Embalmers' Guide

Designed to Accompany

Embalmers' Anatomical Aid.

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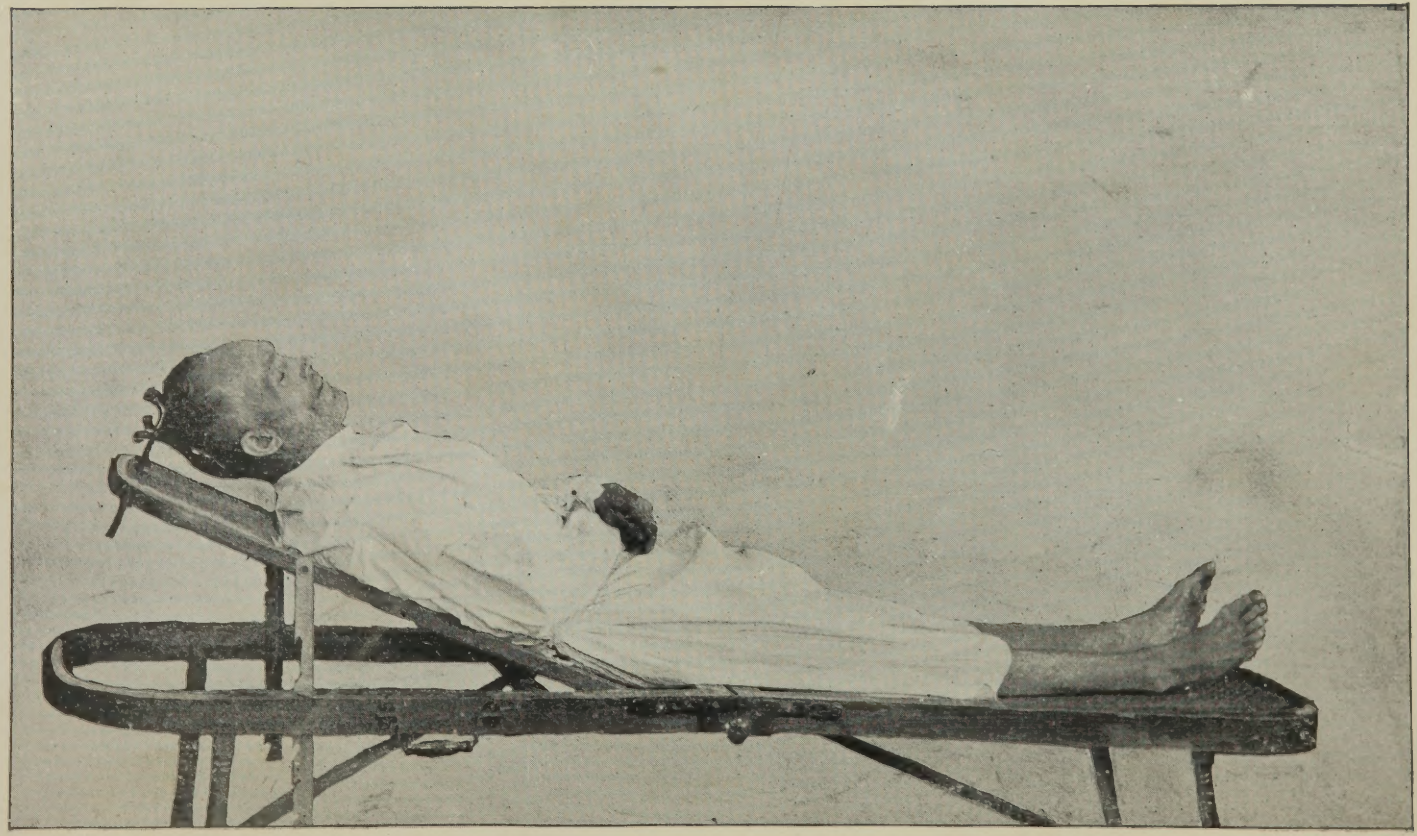

A BODY THOROUGHLY EMBALMED.

EMBALMERS' GUIDE

A Practical and Comprehensive Treatise on Embalming, together with a Complete Description of the Anatomy of the Human Body, Designed to Accompany

THE EMBALMERS' ANATOMICAL AID

PREPARED BY

DR. H. E. LEWIS,

Late Assistant Demonstrator;

WITH

APPENDIX

BY

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AND

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WESTERN PUBLISHING HOUSE,

CHICAGO.

PUBLISHERS' PREFACE.

To the Funeral Directors of America—Greeting:

The Embalmers' Guide has been prepared at large expense and with great care to meet a need which no publication now extant seems to fill. Its various portions are the product of men of national reputation in their various departments, and it is believed that it covers the anatomical and practical field of embalming completely.

Dr. Lewis' work is most exhaustive, treating fully of the arteries and veins, giving in simple language information which it is essential every operator should possess as a basis for a proper understanding and appreciation of the practical directions which follow. The value of the hints and suggestions cannot be over-estimated. They are the condensed experience of a man whose opportunities have been most unusual. As assistant demonstrator at the U. S. College of Embalming in New York, Dr. Lewis was in the way of personally treating or witnessing the treatment by others of every possible case, and this experience has been supplemented by a long and busy career in the profession as a practical embalmer and funeral director. Following his article is an appendix by Dr. Renouard, demonstrator, of the same college. (This college needs no indorsement from us, but we cannot refrain from saying, that, from our personal observation, we believe it would pay every funeral director in the country to take a course of study within its walls.) The illustrations are believed to be a most valuable feature. They are reproductions from

photographs of the operator in the various positions of embalming, and show by object teaching, as nothing else could, the methods, the practical details of the work.

In the following pages you will find a complete Key to the "Embalmers' Anatomical Aid," prepared under the supervision of D. W. Graham, A. M., M. D.; J. Suydam Knox, A. M., M. D.; men of extensive reputation, and who are considered good authority on anatomical questions by the medical profession of the country. This key will give you the name of each organ, also the names of its subordinate parts, throughout the whole system. These names accompany the numbers which correspond to the numbers on the plates, and you will find them to be convenient and valuable to you in reference. We have compiled this Handbook, or Guide, strictly in accordance with the science of Anatomy and Physiology — the terms and names used being those which have been adopted by the professors of these studies throughout the world. You will find, also, a great amount of valuable information contained herein; in particular, we refer to the treatise on Circulation. A knowledge of the arterial circulation is absolutely necessary to the scientific and practical embalmer. It enables him to distinguish readily between the veins and arteries; to know where the fluid goes when he injects it into the arteries, and to know precisely which arteries to operate on and which to avoid. We feel that we cannot say too much regarding the importance of a thorough knowledge of Anatomy and Physiology to the Funeral Director.

The manner of preparing the body for its last resting place is a subject of great importance. In cases where embalming is to be done, is it not necessary that the embalmer should be thorough in his work? Is it not

necessary that the operation shall be scientific, in order to preserve the body from decomposition? In order to make this embalming operation a scientific piece of work, the operator must necessarily be familiar with the arterial circulation, the position of the various organs, their functional relation one to the other, the source of the supply of blood to each, the inflowing and outflowing blood channels through each, and their relative position one to the other. It is also necessary that the embalmer should know where to begin his operations. In short, a practical knowledge of these details is absolutely necessary to the intelligent and satisfactory undertaking of cases of this nature.

Permit us to refer to a case which came under our own observation. A man of considerable note in a certain town, was suddenly cut down in the prime of life. His friends desired to have the body embalmed for transportation from one part of the country to another. A prominent funeral director — one who professed a knowledge of the art of embalming — was called in. The physician in attendance, having, for some reason, little confidence in the ability of this party, questioned him regarding his methods of embalming, and also as to why he pursued such methods. The funeral director was unable to answer his questions further than to say that he had been taught that by his father, whom he succeeded in business. He knew that it was right to do so, but *why* it was right, he could not state. How many men who undertake to embalm bodies are in exactly the same position? They know that it *is* right to do certain things; but if any one should ask them *why* it is right, in a great many cases their answer would correspond with that of the gentleman mentioned. A knowledge of anatomy and the arterial

circulation will enable an embalmer to answer any question as to the why and wherefore of methods pertaining to his business.

To quote from the Code of Ethics of the Funeral Directors' State Association: "On entering the profession, a funeral director incurs an obligation to exert his best abilities to maintain its dignity and honor, to exalt its standing, and to extend the points of its usefulness." We think that in order to fulfill these various obligations, the director should make it his first duty to thoroughly post himself regarding his business. The custom of embalming is growing. It is fast becoming *the* way of preparing the dead for burial. A knowledge concerning the details of anatomy should be considered a paramount duty. To quote from J. S. Pearce in his remarks at a recent convention: "The funeral director of to-day should have a sufficient anatomical and physiological knowledge to enable him to apply his preparations, not only properly, but judiciously, in order that the result that is most desirable may be attained, without having to trust to luck to help him out;" and further, "Authorities are not wanting to prove the truth of this assertion, that embalming is fast making us of more real value to the community than we have heretofore been." The funeral directors of all parts have expended a great amount of money, and have devoted much valuable time to a study of the art of embalming, but have paid little attention to the study of anatomy, and the details of structure. How can an embalmer be successful, or perform a scientific embalming operation without being well acquainted with the details of anatomy? A man might just as well attempt to build a steam-engine without a mechanical education.

Mr. Samson at the National Convention held at Pittsburg on October 5, 1887, said: "I would recommend that we have a standard of qualifications adopted, and a course of study prepared, for persons engaged in our profession. If we do not, we cannot get legal enactments governing the persons who are to prepare the dead for burial, and conduct funerals. If there are not the proper books on the markets, they must be published. We have to go over the same ground that other professionals have gone over, only we have the knowledge of profiting by their experience. We must look to the successful in all professions for our guide. We must keep the educational and elevating influence in front. Something must be done to convince the funeral directors of our land that money spent to improve the mind, elevate and refine the taste, brings a larger return than any other investment they can make."

How closely these words apply to the man of this business who is progressive and practical; in particular to the one who is searching for knowledge for the purpose of elevating his profession and placing it in the same position with the professions of law and medicine. It is one thing to purchase books and appliances, and it is another thing to use them after they have been purchased. A man afflicted with rheumatism may go into a drug store and purchase a bottle of liniment for application; he goes home and makes one or two applications, and sets his bottle of liniment on the shelf. The liniment on the shelf will not cure his rheumatism; he must apply it to the affected parts. Books or appliances on the table, or in the corner, will be of no benefit to the funeral director. He must apply himself to these "avenues of knowledge" to glean from them the desired information. It is a direct duty, both to

himself and to his customers, that he should acquire all the knowledge that is possible. If a person ask him if he can take care of the dead, or whether he can prepare a body for shipment and burial, he should be able to answer, " I can,"—and should give this answer, secure in the knowledge of his own ability, and of the means at hand to impart that knowledge to his patrons if necessary. Thus, a great responsibility rests upon the shoulders of the men of this profession, and they should study to prove themselves worthy of the confidence of their patrons. The time, we think, is fast approaching, when the funeral director will be " tried in the balance;" it therefore stands the profession in hand to prepare themselves for that emergency. Appearances seem to point to the fact that the law will require a thorough anatomical and physiological examination to be passed by a man before he can practice the profession of conducting funerals. The law shelters the public from incompetent people attempting the practice of medicine. If a man attempts to heal the sick, he is required to pass an examination; he receives a diploma which entitles him to practice medicine throughout the land. Now there are many, many people who style themselves practical embalmers, who do not know the first rudiments of embalming. The sooner the profession and the public are protected by the same laws that shield the lawyer, the physician, and the public to whom these minister, against the professional pretensions of incompetent men, the better. To quote from J. B. McIntyre: " Let us not rest satisfied until we have raised the standard of funeral directing, until it is recognized by the laws of the land as one of the regular and legitimate professions." The art of embalming is a grand and important study. The embalmers of America are keenly alive to the neces-

sity of their possessing a thorough knowledge of this art, as it is the coming way of preparing the dead for burial. Special schools are being started all over the country for the purpose of engaging lecturers and demonstrators and professors to impart all the knowledge that is needed on the subject. The public will soon recognize this as a great advance on the part of the profession, and the day will come when their eyes will be opened to the importance and dignity of this calling.

The question at present is, what can be done to advance the interests of the profession? This subject has been gone over many times, and the theory advanced that a State Registry Law is necessary to accomplish the desired result. Before legislation can be obtained upon this particular subject, schools, where instruction is given, and examinations are conducted, by men who have proved themselves masters of the things pertaining to the profession, are necessary.

Much has been said on the subject of sanitary methods of Undertaking. The fact has been proven that embalming, as a means of preparing the dead for burial, is a positive preventive against the spread of contagious diseases. It has also been proven that the "ice-box" of the past days was very instrumental in carrying diseases from one home to another. Methods have been advanced and theories given as to the proper way of disinfecting and cleansing, thereby preventing the spread of contagious diseases, and various Boards of Health have demanded that certain measures be taken to institute sanitary inspections, and enforce sanitary regulations. We believe the time is not far distant when sanitary funeral directing will be also demanded by these Boards of Health in all parts of the country; we also believe that the time is at hand

when the law will require on the part of the person proposing to enter this profession, besides a thorough knowledge of anatomy and physiology, a knowledge of the "laws of health" and sanitary principles. The sooner this is accomplished by the profession, and these laws are put in force, the better, not only for the embalmer, but for the public at large.

In consequence of a demand, on the part of the progressive men of the profession in question, for some means whereby they can enlighten themselves as to the structure of the human body, and by which they can impart to their patrons, confidence in their ability and understanding of their profession, we have prepared the "Embalmers' Guide" and the "Embalmers' Anatomical Aid." We trust that the men who have shown sufficient interest in the progress of their profession to equip themselves with this work, will not — as did the man with the liniment — lay it on the shelf, but will make themselves familiar with its contents. At first sight, the embalmers may say, "There is too much of it — too many details shown — a great many things that do not apply to our business in particular." Do not allow this idea to take possession of you. The time is coming when the embalmer will be called on to evince knowledge of even greater detail than we show in the "Embalmers' Anatomical Aid." We take pleasure in calling your attention to the different sections of the Aid, as they are prepared under the direct supervision of the highest anatomical authority of the country, and the correctness of the various plates is guaranteed.

Sincerely yours,

WESTERN PUBLISHING HOUSE

AUTHOR'S PREFACE.

In the last decade the art of embalming has not only advanced so far beyond former methods as to be scarcely identical with them, but increased excellence and acceptable results have so popularized the art that it is fast becoming *the* mode of preparing the body for its final abode. The former method of packing the body in ice — a method merely temporary in its effects, and doubtless fruitful in spreading contagious diseases — is now almost obsolete, and the services of the embalmer are required in a large proportion of the deaths among the better classes of society. This recognition of the perfection and dignity of the art — grateful as it is — brings, however, additional responsibilities, and necessitates a wider and more scientific intelligence on the part of the embalmer. To-day it is absolutely essential for him to be familiar with the plan and structure of the human organism — its anatomy, and more particularly its angiology. To quote from Professor Renouard: "It is an irrefutable fact, that, if the embalmer is thoroughly conversant with the location and ramifications of those channels through which the blood circulates during life, he must certainly, according to the sequence of undisputable logic, be familiar with the progress and distribution of the antiputrid fluid which is injected into those same channels for the purpose of preservation." In the following pages the author has endeavored to give, in succinct and practical form, that

knowledge of the construction, function and structure of each part of the human frame, essential to an intelligent following of the embalming profession. He has sought to make a Handbook, which, while scientifically accurate, is also plain and self-explanatory — which, while in all essential details complete, is in size convenient for constant carrying and reference. In the chapters descriptive of the different parts of the human body, and in those which deal with the circulation of the blood, constant reference by section, number, or letter, is made to the invaluable plates of the Anatomical Aid. The points of injection shown on the plates of Muscles, Nerves, Veins and Arteries, should be carefully studied as each case demands. The chapters dealing with the general preparation of the body for interment, the selection and injection of arteries, and the cautions and directions in particular and unusual cases, are the outcome of a long and varied experience The author hopes, that, in his desire to emphasize the value of certain procedures, he may not be found repetitious or wearisome. In conclusion, he feels that he cannot urge too strongly the constant need of a higher standard of qualification in the embalmer's profession. To keep abreast in knowledge, in refinement, in general advancement, with other professions, should be the ambition of every funeral director. To quote from J. B. McIntyre: " Let us not rest satisfied until we have raised the standard of funeral directing; until it is recognized by the laws of the land as one of the regular and legitimate professions."

To aid in bringing about such an advanced state of knowledge on this important subject is the aim of this handbook and the great work which it accompanies.

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PART FIRST

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EMBALMERS' GUIDE.

THE BLOOD.

In order to comprehend most fully and easily the art of embalming, it is essential that one should know something of the anatomy of the human body, its organs, and the functions or duties performed by each. This necessitates a brief examination of each part separately, and, as the blood is one of the most important, let us examine its work during life and its condition after death.

Blood is a thick, opaque fluid, varying in different parts of the body from a brilliant scarlet to a dark purple color. In its normal state, it forms about ten per cent. of the bodily weight. Thus, if a man weighs one hundred and fifty pounds, the weight of his blood would be about fifteen pounds.

The circulation of the blood throughout the body requires only about twenty seconds. It is carried to the lungs by the pulmonary arteries (5, Blood Formation) as venous blood, and is carried from the lungs to the left auricle (26) of the heart through the pulmonary vein (17), then carried to the left ventricle (28) of the heart, then to the aorta (4), and thence throughout the entire or general system.

Within a few hours after death the blood becomes thickened or coagulated on account of its remaining quiet

in the veins. The arteries, as a rule, empty themselves into the veins, capillaries, and tissues of the body. Therefore, in preparing to embalm a body, we ordinarily find them empty, although, in some cases, small quantities of blood are retained.

Water forms about seventy per cent. of the human body, and the remaining thirty per cent. is distributed among the tissues, the bones and other organs of the human frame.

DESCRIPTION OF THE ARTERIES.

(See plates in the Aid.)

The arteries are cylindrical, tubular vessels, which serve to convey blood from both ventricles of the heart to all parts of the body. They are strong, elastic, and, when empty, preserve their cylindrical form, and are composed of three distinct coats: the internal serous, the middle fibrous, and the external cellular coat. The arteries are recognized by their pink color in strong contrast with the dark color of the veins, are of various sizes, some of them being of extremely large, and others of very small, caliber.

They contain no valves, so that, when injected, they distribute the fluid throughout the entire system to the remotest corners. They will hold from two to six quarts of fluid, and often much more. During the embalming process the arteries may receive daily injections, using a small quantity at a time. Care should be taken that the injecting tube is placed in the canal of the artery, and not between the tunics or coverings. The arteries empty themselves into the capillaries, which are microscopic vessels, in diameter about one three-thousandth of an inch, their size varying in different parts of the body. The smallest capillaries are those of the brain and of the

mucous membrane of the intestines. Arteries are, as a rule, deep seated, in order that they may be less exposed to injury.

The distribution of the systemic arteries is like a highly ramified tree, the trunk formed by the aorta (4, Blood Formation), and its many ramifications forming the branches. The arteries divide and subdivide, running into the most distant parts of the body, the larger arteries usually occupying the most protected situations. Generally the larger arterial branches pursue a perfectly straight course, but in certain places and situations they are very tortuous ; thus the facial artery, in its course over the face, the internal carotid, and the vertebral arteries just before they enter the cavity of the skull, describe a series of curves which are evidently intended to diminish the velocity of the current of blood by increasing the extent of surface over which it moves.

THE PULMONARY ARTERY.

(B, plate of Lungs; also 5, Blood Formation.)

The pulmonary artery conveys the impure blood from the right side of the heart to the lungs. It is a short, wide vessel about two inches in length, and rises from the left side of the base of the right ventricle (27, Blood Formation) in front of the aorta. It ascends upward, backward and to the left side, and winds spirally in front of and then to the left of the ascending part of the arch of the aorta (4, Blood Formation) as far as the under surface of the transverse portion of the arch, where it divides into two branches of nearly equal size — the right and left pulmonary arteries.

The right pulmonary artery (5, Blood Formation) is longer and larger than the left, runs outward behind the

ascending aorta and superior vena cava (13, Blood Formation) to the root of the right lung, when it divides into two branches. The left pulmonary artery (5, Blood Formation) passes in front of the descending aorta.

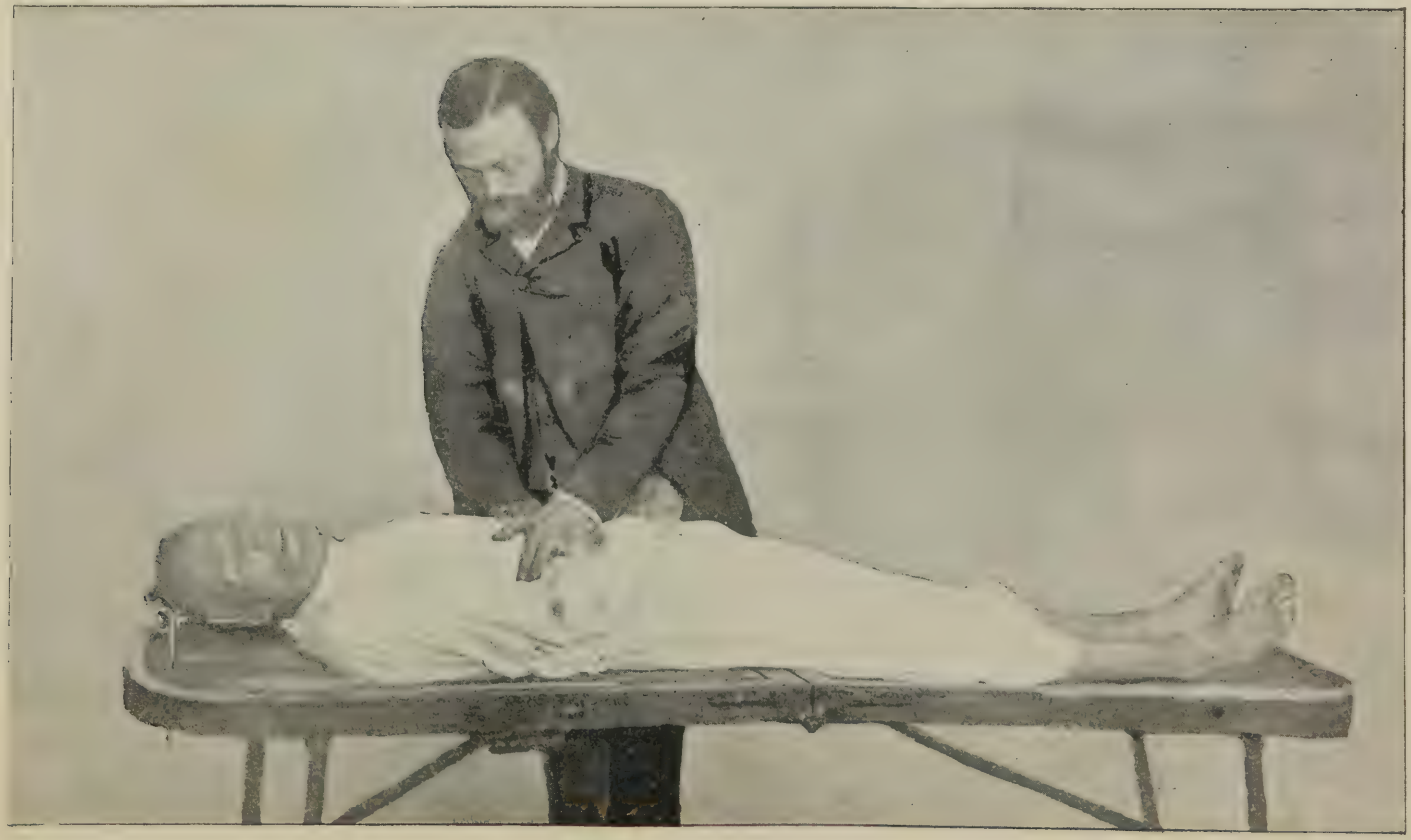
THE AORTA.

(See Blood Formation in Aid.)

The aorta (4) is the main trunk of a series of vessels, which, arising from the heart, convey the red oxygenated blood to every part of the body for its nutrition. This vessel commences at the upper part of the left ventricle, and, after ascending for a short distance, arches backward and to the left side over the root of the left lung, descends within the thorax, passes through the aortic opening in the diaphragm, and enters the abdominal cavity, terminating opposite the fourth lumbar vertebra (12, Skeleton plate), there dividing into the right and left common iliac arteries (F, back plate Body).

The portion of the aorta situated in the thorax is called the thoracic aorta (6, Blood Formation), and, after passing through the diaphragm and entering the abdomen, it is called the abdominal aorta (10, Blood Formation). The aorta, and more especially its arch, is frequently the seat of disease, aneurisms often occurring at this point.

The branches given off from the arch of the aorta are five in number, the *right* and *left coronary*, the *innominate* (2, Blood Formation), the *left common carotid* (1, Blood Formation), and the *left subclavian* (3, Blood Formation). The coronary arteries (Heart plate) supply the heart, and arise near the commencement of the aorta, just above the free margin of the semilunar valves (Heart plate). The right coronary artery, about the size of a quill, rises from



OPERATOR PURGING THE BODY.

(See page 105.)

the aorta immediately above the right semilunar valve, between the pulmonary artery (B, Heart plate) and the right auricular appendix (b, Heart plate). It passes through the right side in the groove between the right auricle and ventricle, and, curving around the right border of the heart, runs along its posterior surface as far as the posterior interventricular groove. It then divides into two branches, one of which continues in the groove between the left auricle and ventricle, and anastomoses with the left coronary; the other descends along the posterior interventricular furrow, and supplies branches to both ventricles and to the septum. The left coronary artery is larger than the right, rises immediately above the free edge of the left semilunar valve, a little higher than the right, passes between the pulmonary artery (B, Lung plate) and the left appendix auriculæ (d, Heart plate), and descends toward the anterior interventricular groove, where it divides into two branches. One branch passes transversely outward in the left ventricular groove, and winds around the left border of the heart to its posterior surface; the other descends along the anterior interventricular groove to the apex of the heart, where it anastomoses with the descending branches of the right coronary artery. The left coronary artery supplies the left auricle and its appendix, both ventricles, and a number of small branches to the pulmonary artery and the commencement of the aorta.

The innominate artery (2, Blood Formation) is the largest branch given off from the arch of the aorta. It rises from the commencement of the transverse portion in front of the left carotid artery (1, Blood Formation), ascends to the upper border of the right sterno-clavicular articulation, and divides into the right common carotid

(1, Blood Formation) and subclavian arteries (3, Blood Formation). Of the common carotid arteries, the right rises from the arteria innominata behind the right sterno-clavicular articulation; the left, placed more deeply in the thorax, ascends outward from the arch of the aorta to the root of the neck. In front it is separated from the first piece of the sternum by the sterno-hyoid and the sterno-thyroid muscles, and the left innominate vein (14, Blood Formation). In the neck, the two common carotids resemble each other so closely that one description will answer for both. Each vessel passes upward from behind the sterno-clavicular articulation (9, plate of Ribs-Thorax) to a level with the upper border of the thyroid cartilage (d, plate of Muscles), where it divides into the external and the internal carotid arteries.

The course of the common carotid is direct from the sternal end of the clavicle (f, Muscles) to the mastoid process above; this point is indicated by the lower lobe of the ear. At the lower part of the neck, the common carotid artery is very deeply seated, being covered by the superficial fascia, platysma, deep fascia, the sterno-mastoid (18, Muscles), sterno-hyoid (19, Muscles) and sterno-thyroid (d, Muscles) muscles. In the upper part of its course, near where it terminates, it is quite superficial. The external carotid artery (19, Head plate) commences opposite the upper border of the thyroid cartilage (d, muscles), takes a slight curved course, runs upward and forward, then inclines backward, and then divides into the temporal (18, Head plate) and internal maxillary arteries (35 and 23, Head plate). The facial artery (20, Head plate) arises a little above the lingual, and runs forward and upward beneath the lower jaw, then curves upward over the body of the jaw, runs forward and upward,

and crosses the cheek to the angle of the mouth, passes up alongside of the nose, and, under the name of the angular artery, terminates at the inner canthus of the eye. The facial artery, both in the neck and on the face, is very tortuous and very superficial; its pulsations may be distinctly felt by slight compression against the bone. In its course over the face, it is covered by the fat of the cheek and is accompanied by the facial vein (17, Head plate) throughout its entire course, though the vein is not so tortuous as the artery. The anastomoses of the artery are very numerous.

The occipital artery (3, Head plate) arises from the posterior part of the external carotid, opposite the facial. At its origin, it is covered by the posterior belly of the digastric and stylo-hyoid muscles, and part of the parotid gland; higher up it crosses the internal carotid artery and the internal jugular vein, then ascends to the interval between the transverse process of the atlas, and the mastoid process of the temporal bone, then changes its course and passes vertically upward. The temporal artery (7 a, Incision plate) is the smaller of the two terminal branches of the external carotid artery, and appears, from its direction, to be the continuation of that vessel. It divides into two branches, an anterior and a posterior.

The anterior temporal inclines forward over the forehead and anastomoses with the supraorbital and frontal arteries; the posterior temporal is larger, curves upward and backward along the side of the head, and inosculates with its fellow of the opposite side and with the posterior auricular and occipital arteries (3, Head plate).

The internal maxillary (35, Head plate) is the largest of the terminal branches of the external carotid artery, passes inward at right angles from that vessel to the inner side

of the neck, and supplies the deep structures of the face. The internal carotid artery commences at the bifurcation of the common carotid artery, opposite the upper border of the thyroid cartilage, and runs perpendicularly upward in front of the transverse processes of the three upper cervical vertebræ, to the carotid foramen in the petrous portion of the temporal bone; after ascending for a short distance, it passes forward and inward through the carotid canal and enters the skull.

The internal carotid artery supplies the anterior part of the brain, the eye, and its appendages, and sends branches to the forehead and the nose, its size in the adult equaling that of the external carotid. Its course is curved, thus diminishing the velocity of the current of blood by increasing the extent of surface over which it moves. It is divided into four portions, the *cervical*, the *petrous*, the *cavernous*, and the *cerebral*.

The cervical portion is superficial at its commencement, being contained in the superior carotid triangle, and lying on the same level as the external carotid; but back of that artery it passes beneath the parotid gland, and is crossed by the external carotid and occipital arteries. When the internal carotid artery enters the canal in the petrous portion of the temporal bone, it first ascends a short distance, then curves inward, and again ascends as it leaves the canal to enter the skull cavity. The cavernous portion at first ascends to the posterior clinoid process, then passes forward by the side of the body of the sphenoid bone. The cerebral portion of the artery is on the outer side of the optic nerve.

The ophthalmic artery rises from the internal carotid artery just as that vessel is emerging from the cavernous sinus on the inner side of the anterior clinoid process, and

enters the orbit through the optic foramen. The frontal artery (Forehead), one of the terminal branches of the ophthalmic, passes from the orbit at its inner angle, and, ascending on the forehead, supplies the muscles, and anastomoses with the supraorbital artery (Eye). The nasal artery, the other terminal branch of the ophthalmic artery, emerges from the orbit above the tendo oculi, and divides into two branches, one of which anastomoses with the angular artery; the other runs along the dorsum of the nose, supplies its entire surface, and anastomoses with the artery of the other side.

The cerebral branches of the internal carotid are, the *anterior cerebral*, the *middle cerebral*, the *posterior communicating*, and the *anterior choroid*. The anterior cerebral (Head plate) rises from the internal carotid at the inner extremity of the fissure of Sylvius, passes forward between the two anterior lobes of the brain, soon after its origin being connected with the vessel of the opposite side by a short anastomosing trunk about one inch in length. The anterior communicating artery (Head plates) is a short branch about one inch in length, but of moderate size, connecting the two anterior cerebral arteries. Across the longitudinal fissure, the two arteries join to form a single front, which afterward subdivides, or the vessel may be wholly or partially subdivided into two portions. The middle cerebral is the largest branch of the internal carotid, passes outward along the fissure of Sylvius, where it divides into three branches: an anterior, which supplies the pia mater; a posterior, which supplies the middle lobe; and a median branch, which supplies the small lobe at the outer extremity of the Sylvian fissure. The posterior communicating artery arises from the back part of the internal carotid, runs directly backward and anas-

tomoses with the posterior cerebral, a branch of the basilar. This artery varies considerably in size, occasionally being so large that the posterior cerebral may be considered as arising from the internal carotid, rather than from the basilar.

The anterior choroid (Head plate) is a small but constant branch with rises from the back part of the internal carotid near the posterior communicating artery; passing backward and outward, it enters the descending horn of the lateral ventricle, beneath the edge of the middle lobe of the brain

THE BLOOD-VESSELS OF THE BRAIN.

The arteries of the brain are derived from the internal carotid and the vertebral arteries. On the left side, these vessels rise at such an angle that the blood current is much more direct than on the right; thus accounting for the larger size and development of the left hemisphere. At the base of the brain, these four vessels form the circle of Willis. This circle consists of two sets of vessels, the anterior or carotid set, from which arise the anterior and middle cerebral arteries (Head plate), and the posterior or vertebral set, consisting of the basilar and posterior cerebral arteries. Each set has a free anastomosis from side to side.

ARTERIES OF THE UPPER EXTREMITY.

(See plates in Aid.)

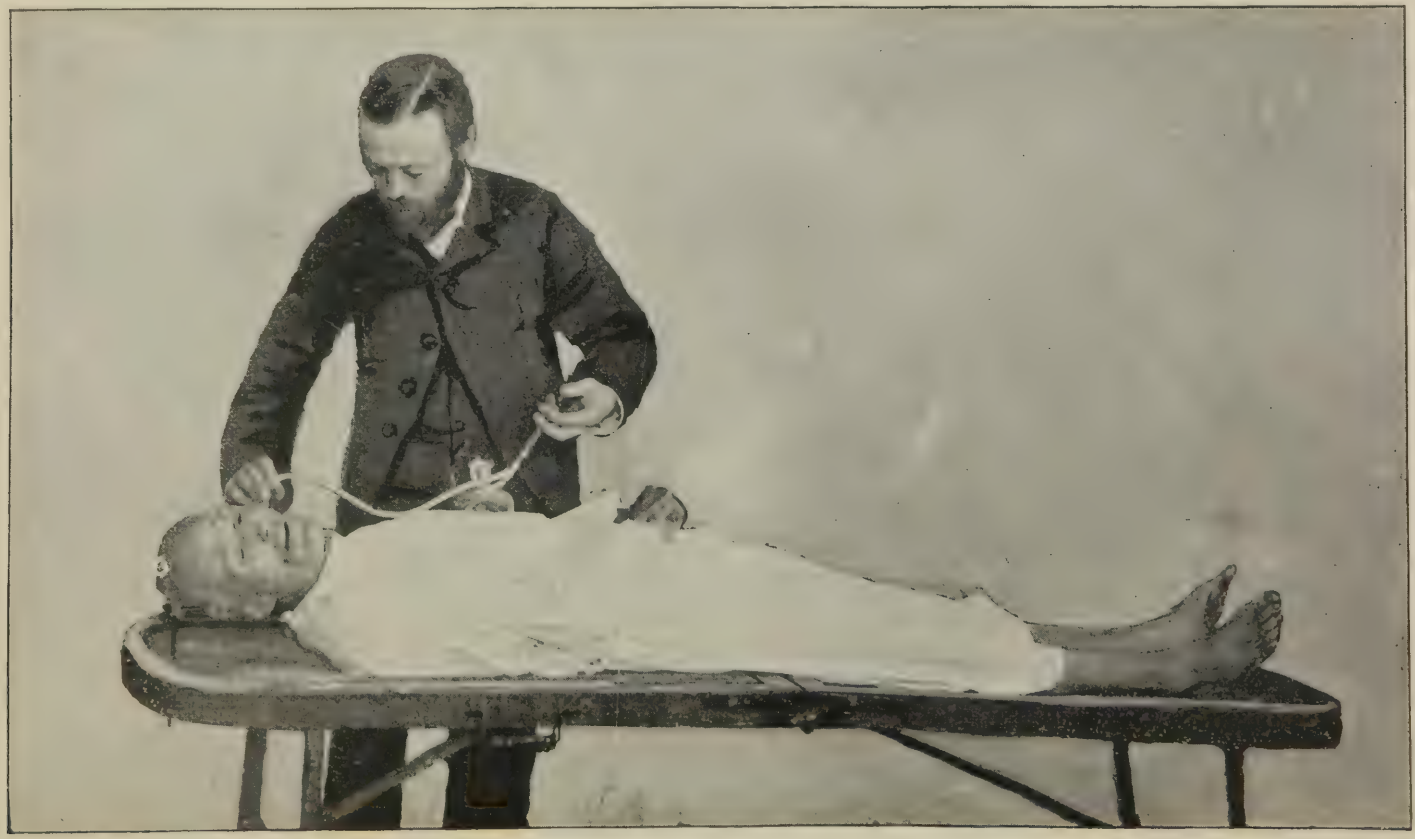
The artery which supplies the upper extremity continues as a single trunk from its commencement down to the elbow; but different portions of it have received different names according to the region through which it passes. That part of the vessel which extends from its origin to

the lower border of the first rib is termed the subclavian artery (3, Blood Formation). Beyond this point to the lower border of the axilla it is termed the axillary artery (A, plate 4, Upper Extremity), and from the lower margin of the axillary space to the bend of the elbow it is termed the brachial artery (A, plate 2, Upper Extremity). At this point the single trunk terminates by dividing into two branches, the radial (B, plate 2, Upper Extremity), and the ulnar (G, plate 2, Upper Extremity), an arrangement precisely similar to that occurring in the lower limb.

The subclavian artery (3, Blood Formation) on the right side arises from the arteria innominata (2, Blood Formation) opposite the right sterno-clavicular articulation, and on the left from the arch of the aorta (4, Blood Formation); therefore these two vessels in the first part of their course differ in their length, their direction, and their relation with neighboring parts. The right subclavian artery (3, plate, Blood Formation) (4a, Incision plate) arises from the arteria innominata (1, Blood Formation) opposite the right sterno-clavicular articulation, passes upward across the root of the neck, and terminates at the inner margin of the scalenus anticus muscle, and in this part of its course ascends a little above the clavicle (5, Rib plate), the extent to which it does so varying in different cases. It is crossed by the internal jugular (16, Blood Formation) and vertebral veins. The left subclavian artery (3, Blood Formation) arises from the end of the transverse portion of the arch of the aorta (4, Blood Formation), ascends to the inner margin of the first rib, is longer than the right, situated more deeply in the cavity of the chest, and directed almost vertically upward, instead of arching outward like the vessel of the opposite side.

The vertebral artery (Blood Formation) is the first and

largest branch of the subclavian, rises from the upper and back part of that vessel, passes upward and enters the foramen in the transverse process of the sixth cervical vertebra. It ascends through the foramina in the transverse processes of all the vertebræ above the sixth, and above the upper border of the axis it inclines upward to the foramen in the transverse process of the atlas, through which it passes. It enters the skull through the foramen magnum, then passes upward to the front of the medulla oblongata (45, Head plate), and unites with the vessel of the opposite side at the lower border of the pons Varolii to form the basilar artery. Within the skull it winds around the medulla oblongata. The basilar artery (Head plate), so named from its position at the base of the skull, is a single trunk formed by the two vertebral arteries. It extends from the posterior to the anterior border of the pons Varolii, and has several branches ; namely, the *transverse*, the *anterior inferior cerebellar*, *superior cerebellar*, and the *posterior cerebral*. The transverse branches supply the pons Varolii and adjacent parts of the brain ; the superior cerebellar (Head plate) rises near the termination of the basilar, and, on arriving at the upper circle of the cerebellum, they divide into branches which ramify in the pia mater and anastomose with the inferior cerebellar ; the posterior cerebral, the two terminal branches of the basilar, are larger than the preceding, anastomose with the anterior and middle cerebral artery, and near their origin receive the posterior communicating arteries from the internal carotid, and give off numerous branches which enter the posterior perforated space. The remarkable anastomoses which exist between the branches of the internal carotid and vertebral arteries at the base of the brain, constitute the circle of Willis. This circle is formed in



OPERATOR INJECTING THE EYES.

(See page 106.)

front by the anterior cerebral arteries, and branches of the internal carotid, which are connected together by the anterior communicating artery; behind by the two posterior cerebral branches of the basilar, which are connected through the internal carotid by the posterior communicating artery. It is by this anastomosis that the cerebral circulation is equalized and provision made for effectually carrying it on if any of the branches should be damaged or obliterated. The internal mammary artery (Breast) arises from the under surface of the first portion of the subclavian artery, descends behind the clavicle to the inner surface of the chest, rests against the costal cartilages a short distance from the margin of the sternum, and divides into two branches.

The axillary artery (A, plate 4, Upper Extremity), the continuation of the subclavian, commences at the lower border of the first rib, and terminates at the lower border of the tendon of the teres major muscle, where it takes the name of the brachial (B, plate 4, Upper Extremity). Its direction varies with the position of the limb, as, when the arm lies by the side of the chest, the vessel forms a gentle curve, the convexity being upward; when the limb is directed at right angles with the trunk, the vessel is nearly straight; when elevated, it describes a curve. At its commencement, the artery is very deeply situated, but near its termination is quite superficial, being covered only by the skin and fascia. The subscapular (plate 4, Upper Extremity) is the largest branch of the axillary artery, arises opposite the lower border of the subscapularis muscle, and passes downward. The posterior and anterior circumflex arteries wind around the neck of the humerus; the posterior circumflex (1, plate 4, Upper Extremity) is the larger of the two, rises from the back part

of the axilla, and, passing backward with the circumflex veins, anastomoses with the anterior circumflex (A, plate 4, Upper Extremity) and thoracic arteries, and with the superior profunda branch (L, plate 4, Upper Extremity) of the brachial artery; the anterior (H, plate 4, Upper Extremity) arises just below that vessel from the outer side of the axillary artery.

The brachial artery (B, plate 4, Upper Extremity) commences at the lower margin of the tendon of the teres major, and, passing down the inner and anterior aspect of the arm, terminates about one-half inch below the elbow, where it divides into the radial (B, plate 2, Upper Extremity) and ulnar arteries (G, plate 2, Upper Extremity). Like the axillary, the direction of the brachial artery varies with the position and situation of the arm; if the arm be directed downward by the side of the body, the artery takes a spiral course, and is much deeper seated; but, if the arm is held in a horizontal position or directly outward with the palmar suface of the hand upward, its course is almost on a straight line and nearer the surface, making it more superficial, and decidedly easier for the operator to reach. When about to take up the brachial artery for an injective point, turn the hand with the palm upward, as this will bring the artery to the desired position. In the upper part of the arm, the artery lies internal to the bone; but below it is in front, lying between the border of the biceps and triceps muscles, which make a good landmark; it is always accompanied by two companion veins, the venæ comites (5, plate 2, Upper Extremity), and the nerve of the arm. These are sometimes found in one sheath, and can be separated very easily. For the purpose of injecting, the brachial artery is universally used by embalmers, as it is easily found, and affords the

operator a chance to hide or cover up his work, which in some cases is very important. In embalming a child, however, the brachial artery would practically be useless, as its caliber is so small. With children it is advisable to use the carotid or the femoral artery, preferably the latter, as there is no danger of injury or of discoloration. Give the tubing a downward course, and naturally the fluids distribute to the lower extremity first, the upper extremities receiving the injection more slowly, as the branches take off the recurring current. In raising the brachial artery for embalming purposes, it is well to make incision about two inches below the axilla, as in that position the small branches can be avoided and considerable leakage be prevented. The radial artery (B, plate 2, Upper Extremity), though smaller, appears from its direction to be the continuation of the brachial artery. It commences at the bifurcation of the brachial, just below the bend of the elbow, and passes along the radial side of the forearm to the wrist, then winds backward around the outer side of the wrist beneath the extensor tendons of the thumb, and finally passes forward between the two heads of the first dorsal interosseous muscle into the palm of the hand, where it crosses the metacarpal bones to the ulnar border of the hand to form the deep palmar arch (G, plate 2, Upper Extremity). At its termination it inosculates with the deep branch of the ulnar artery.

The radial artery is accompanied by the radial nerve (1, last plate, Upper Extremity), lying on the radial side of the radial artery, and by its two companion veins, the venæ comites. If occasion should require, the radial artery may be used for injecting purposes, sometimes with very good results ; but, as it is smaller than the ulnar, and exposed to view at the wrist, where it is quite superficial,

this is not advisable where a larger and more convenient artery is available. The operation, also, would necessarily be very slow.

The ulnar artery (G, plate 2, Upper Extremity), the larger of the two subdivisions of the brachial, commences a little below the bend of the elbow, and crosses the inner side of the forearm obliquely inward to the commencement of its lower half; it then runs along its ulnar border to the wrist, crosses the annular ligament on the radial side of the pisiform bone, and passes across the palm of the hand, forming the superficial palmar arch. This arch describes a curve with its convexity to the fingers and to the space between the ball of the thumb and the index finger, where it anastomoses with a branch from the radialis indicis, thus completing the arch. If the thumb be placed at right angles to the hand, its position will be indicated by a line drawn along the lower margin of the thumb, across the palm. It is covered by the palmar fascia, the palmaris brevis and integument. The deep palmar arch is situated about one finger's breadth nearer the carpus. The ulnar nerve (K, plate 3, Upper Extremity) accompanies the artery (E, plate 3, Upper Extremity) a short part of its course. The ulnar artery gives off ten branches, of which those in the forearm are called the *anterior ulnar recurrent* (G, lower part plate 4, Upper Extremity), the *posterior ulnar recurrent*, the *interosseous* (H, lower part plate 4, Upper Extremity), the *anterior interosseous*, the *posterior interosseous*, and the *muscular;* those in the wrist are the *anterior carpal* and the *posterior carpal;* those in the hand are the *deep* or *communicating* branch and the *digital.*

The anterior ulnar recurrent branch rises immediately below the elbow joint, passes inward, and supplies the brachialis anticus and pronator radii teres muscles; the

posterior ulnar recurrent branch is much larger, and, rising a little lower, passes backward and inward beneath the flexor sublimis, and ascends behind the inner condyle of the humerus, supplying the neighboring joints and muscles, and anastomosing with the inferior profunda and interosseous recurrent arteries. The interosseous artery (H, lower part Upper Extremity, plate 4) is a short trunk about one inch in length, and of considerable size. It rises immediately below the tuberosity of the radius, and divides into two branches, the anterior and posterior interosseous. The anterior interosseous artery passes down the forearm on the anterior surface of the interosseous membrane, accompanied by the interosseous branch of the median nerve, then down behind the pronator quadratus, and anastomoses with the posterior interosseous artery. The posterior interosseous artery passes backward through the interval between the oblique ligament and the upper border of the interosseous membrane; descending to the wrist, it anastomoses with the termination of the anterior interosseous, and with the posterior carpal branches of the radial and ulnar arteries. Near its origin it gives off the interosseous recurrent branch. The muscular branches are distributed through the muscles along the ulnar side of the forearm. The carpal branches (1, plate 4, Upper Extremity) supply the wrist joint. Of these, the anterior carpal is a small vessel which crosses the front of the carpus and inosculates with a corresponding branch of the radial artery; the posterior carpal arises immediately above the pisiform bone, and winds backward beneath the tendon of the flexor carpi ulnaris. It anastomoses with a corresponding branch of the radial artery, and, forming the posterior carpal arch immediately after its origin, it gives off a small branch which runs along the ulnar side of the metacarpal

bone of the little finger, forming one of the metacarpal arteries and supplying the ulnar side of the dorsal surface of the little finger. The deep or communicating branch arises at the commencement of the palmar arch, anastomoses with the termination of the radial artery, and thus completes the deep palmar arch. The digital branches (lower part plate 5, Upper Extremity) are four in number, and are given off from the convexity of the superficial palmar arch. They supply the ulnar side of the little finger, and the adjoining sides of the four fingers, the radial side of the index finger and thumb being supplied from the radial artery. The digital arteries are at first superficial; but, as they pass forward to the clefts between the fingers, they lie between them, and are there joined by the interosseous branches from the deep palmar arch. The digital arteries on the sides of the fingers lie beneath the digital nerves, and, about the middle of the last phalanx, the two branches for each finger form an arch.

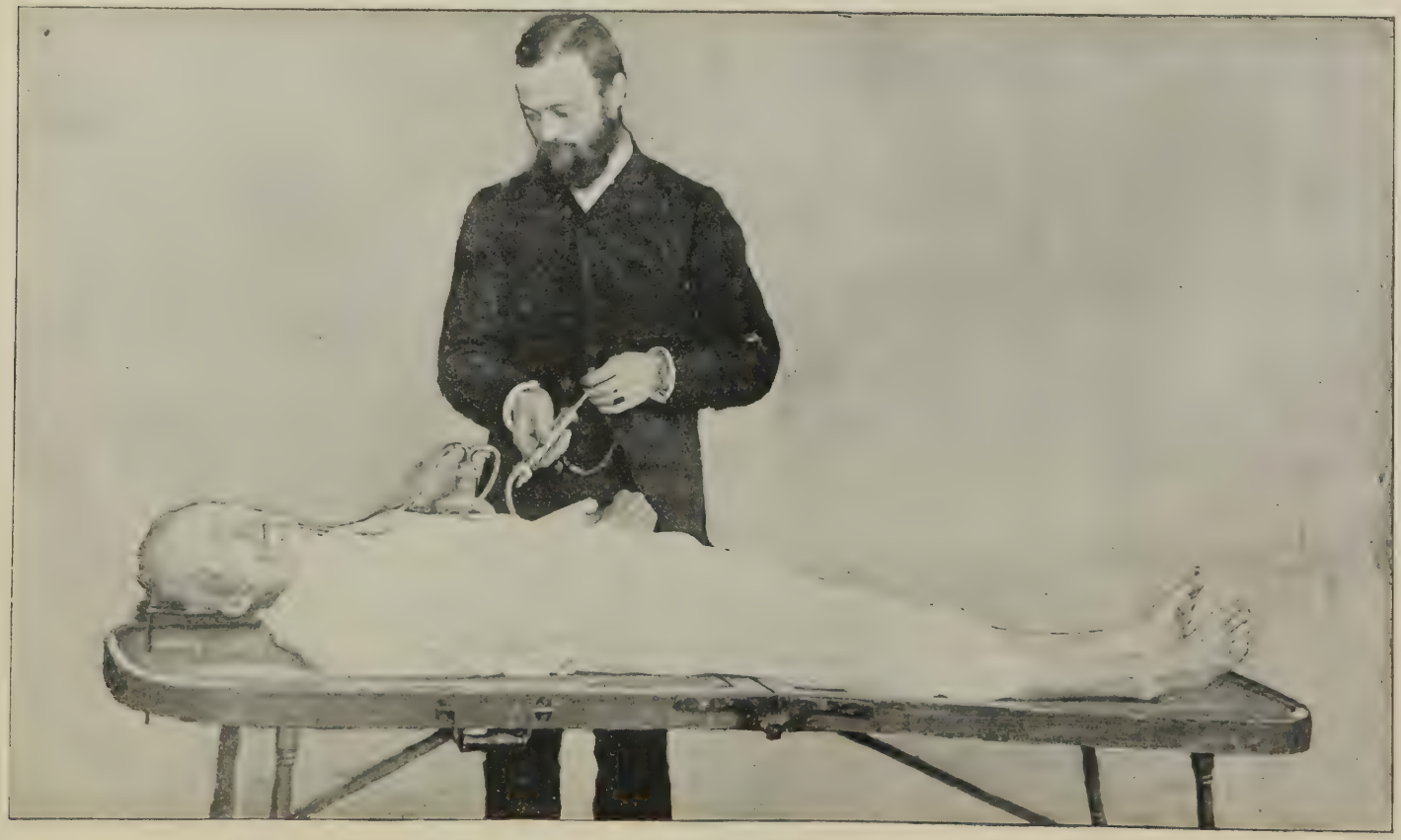
The descending aorta (4, Blood Formation) is divided into two portions, the *thoracic* (6, Blood Formation) and the *abdominal* aorta (a, back plate Body), in correspondence with the two great cavities of the trunk, in which it is situated. The thoracic aorta (6, Blood Formation) commences at the lower border of the fifth dorsal vertebra on the left side, and terminates at the aortic opening in the diaphragm, in front of the last dorsal vertebra. At its commencement, it is situated on the left side of the spine, approaches the median line as it descends, and at its termination lies directly in front of the column. As its branches are small, the diminution in the size of the vessel is inconsiderable. In front it is in relation from above downward with the left pulmonary artery (5, Blood Forma-

tion), behind with the vertebral column and the vena azygos minor, on the right side with the vena azygos major and the thoracic duct (29, Blood Formation), on the left side with the pleura and lung.

The branches of the thoracic aorta (6, Blood Formation) are the *pericardiac*, the *bronchial*, the *œsophageal*, the *posterior mediastinal*, and the *intercostal*. The pericardiac arteries are a few small vessels irregular in their origin and distributed to the pericardium. The bronchial arteries are the nutrient vessels of the lungs, and vary in number, size and origin; that of the right side rises from the first aortic intercostal, or by a common trunk with the left bronchial, from the front of the thoracic aorta; those of the left side, usually two in number, rise from the thoracic aorta, one a little lower than the other. The œsophageal arteries, usually five in number, rise from the front of the aorta, and pass downward to the œsophagus, anastomosing with the œsophageal branches of the inferior thyroid arteries above, and with ascending branches from the phrenic and gastric arteries below. The posterior mediastinal arteries are many but small vessels which supply the glands and loose areolar tissue in the mediastinum. The intercostal arteries, of which there are usually ten pairs, rise from the back part of the aorta, and lie on each side of the superior intercostal space. The right arteries are longer than the left, and, on account of the position of the aorta on the left side of the spine, they pass outward across the bodies of the vertebræ to the intercostal spaces, being covered by the pleura, the œsophagus, the thoracic duct and vena azygos major. The left pass beneath the superior intercostal vein, the azygos vein, the vena azygos minor and sympathetic. In the intercostal spaces, each artery divides into two branches, an anterior and a poste-

rior branch. The anterior branch passes outward, then between the two layers of intercostal muscles, and, having ascended to the lower border of the rib above, divides near the angle of that bone into two branches. Of these, the larger runs in the groove on the lower border of the rib above; the smaller, along the upper border of the rib below. As they pass forward, they supply the intercostal muscles, and anastomose with the anterior intercostal branches of the internal mammary and with the thoracic branches of the axillary artery. The first aortic intercostal artery anastomoses with the superior intercostal, and the last three pass between the abdominal muscles, inosculating with the epigastric in front, and with the lumbar arteries. Each intercostal artery is accompanied by a vein and nerve, the former above, the latter below, and are protected from pressure during the action of the intercostal muscles by fibrous arches thrown across and attached by each extremity to the bone. The posterior branch of each intercostal artery passes backward to the inner side of the anterior costo-transverse ligament, and divides into a spinal branch, which supplies the vertebræ, the spinal cord and its membranes.

The abdominal aorta (A, last plate Body) commences at the aortic opening of the diaphragm in front of the body of the last dorsal vertebra, and, descending a little to the left side of the vertebral column, terminates on the body of the fourth lumbar vertebra, generally to the left of the median line, where it divides into the two common iliac arteries (F, last plate Body). It diminishes in size very rapidly in consequence of the many large branches which it gives off. It is covered in front by the stomach, behind which are the branches of the cœliac axis and the solar plexus, and below these by the splenic vein (21, Blood



OPERATOR INJECTING THE NOSTRILS.

(See page 106.)

Formation), the pancreas (19, last plate Body), the left renal vein (W, last plate Body), the transverse portion of the duodenum, the mesentery and the aortic plexus. Behind, it is separated from the lumbar vertebra by the left lumbar veins (A, last plate Body) and thoracic duct (29, Blood Formation). On the right side it is in relation with the inferior vena cava (E, last plate Body); on the left with the sympathetic nerve and left semilunar ganglion. The single branches of the abdominal aorta (A, last plate Body) are the *cœliac axis* (7, Blood Formation), the *superior mesenteric* and the *inferior mesenteric* (Y, last plate Body).

The cœliac axis (see Blood Formation) is a short, thick trunk about one-half inch in length, which arises from the aorta opposite the margin of the diaphragm, and, passing horizontally forward, divides into three large arteries — the *gastric* (7), the *hepatic* (8), and the *splenic* (9), and occasionally giving off one of the *phrenic* arteries. It is covered by the lesser omentum on the right side, is in relation with the right semilunar ganglion and the lobus Spigelii; on the left side with the left semilunar ganglion and cardiac end of the stomach, and below rests on the upper border of the pancreas. The gastric artery (7, Blood Formation), the smallest of the three branches of the cœliac axis, passes up and to the left side to the cardiac orifice of the stomach, distributing branches to the œsophagus, which anastomose with the aortic œsophageal arteries, and others which supply the cardiac end of the stomach, inosculating with branches of the splenic artery. It then passes from left to right along the lesser curvature of the stomach to the pylorus, and at its termination anastomoses with the pyloric branch of the hepatic artery. The hepatic artery (8, Blood Formation) is intermediate

in size between the gastric and splenic arteries. It is first directed forward and to the right, to the upper margin of the pyloric orifice of the stomach, forming the lower boundary of the foramen of Winslow, then passes upward between the layers of the lesser omentum and in front of the foramen of Winslow to the transverse fissure of the liver, where it divides into two branches — right and left — which supply the corresponding lobes of that organ. This artery, in its course along the right border of the lesser omentum, is in relation with the portal veins. The cystic artery, a branch of the hepatic, passes upward along the neck of the gall-bladder, and divides into two branches, one of which ramifies on its free surface, the other between it and the substance of the liver. The splenic artery (9, Blood Formation) is the largest of the three branches of the cœliac axis, and is very tortuous in its course. Accompanied by the splenic vein, which lies below, it passes along the left side of the upper border of the pancreas, and, on arriving near the spleen, divides into branches, some of which are distributed to the great end of the stomach, and others, the pancreatic, to the pancreas.

The superior mesenteric artery (11, Blood Formation) supplies, with the exception of the first part of the duodenum, the whole length of the small intestine, the cæcum, and ascending and transverse colon. It is a very large vessel arising from the fore part of the aorta about one-fourth inch below the cœliac axis, being covered at its origin by the splenic vein (21, Blood Formation) and pancreas. It passes forward between the transverse portion of the pancreas and duodenum, crosses in front of this portion of the intestine, and descends between the layers of the mesentery to the right iliac fossa, where,

diminished in size, it terminates. In its course it forms an arch, is accompanied by the superior mesenteric vein and has five branches. The inferior pancreatico-duodenal branch is given off behind the pancreas, and anastomoses with the superior pancreatico-duodenal artery; the ileo-colic is the lowest branch given off from the concavity of the artery; the colica dextra branch arises from about the middle of the concavity of the artery, and, passing beneath the peritoneum to the middle of the ascending colon, divides into two branches, one descending and one ascending; the colica media branch arises from the upper part of the concavity of the artery, and, passing forward between the layers of the transverse meso-colon, divides into two branches — the one on the right side inosculating with the colica dextra, and that on the left with the colica sinistra, a branch of the inferior mesenteric.

The inferior mesenteric artery (Y, last plate Body) supplies the descending and sigmoid flexure of the colon (14, Stomach plate) and the greater part of the rectum. It is smaller than the superior mesenteric, and arises from the left side of the aorta between one and two inches above its division into the common iliacs, passes downward to the left iliac fossa, and then descends, under the name of the superior hæmorrhoidal arteries, between the layers of the meso-rectum into the pelvis. It lies at first in close relation with the left side of the aorta, and then passes, as the superior hæmorrhoidal artery, in front of the left common iliac artery, dividing into the *colica sinistra*, *sigmoid* and *superior hæmorrhoidal* branches. Of these the colica sinistra passes behind the peritoneum in front of the left kidney to reach the descending colon, and divides into an ascending and descending branch; the sigmoid artery runs downward across the psoas muscle to the sigmoid flexure

of the colon, and divides into branches which supply that part of the intestine, anastomosing above with the colica sinistra, and below with the superior hæmorrhoidal branches; the superior hæmorrhoidal ascends into the pelvis, crossing in its course the ureter and left common iliac vessels, dividing, opposite the middle of the sacrum, into two branches, which descend one on each side of the rectum, where they divide into several small branches, which are distributed between the mucous and muscular coats of that tube nearly as far as its lower end, anastomosing with each other, with the middle hæmorrhoidal artery, and branches of the internal iliac artery.

The supra-renal arteries are two small vessels rising one on each side of the aorta, opposite the superior mesenteric artery, and passing upward to the under surface of the supra-renal capsules, to which they are distributed. They anastomose with capsular branches from the phrenic and renal arteries, and in the adult are of small size.

The renal arteries (V, last plate Body) are two large trunks which rise from the sides of the aorta immediately below the superior mesenteric artery, each directed outward so as to form nearly a right angle with that vessel. Previous to entering the kidney, each artery divides into four or five branches which are distributed to its substance.

The spermatic arteries (X, last plate Body) distributed to the testes in the male, and the ovaria in the female, are two slender vessels of considerable length which arise from the front of the aorta just below the renal arteries. On reaching the margin of the pelvis (22, last plate Body) each vessel passes in front of the corresponding iliac artery, in the male being directed outward to the internal abdominal ring, and accompanying the other constituents of the sper-

matic cord (18, Male Genital Organs), along the spermatic canal to the testes (20, Male Genital Organs), where it divides into several branches. In the female, the spermatic arteries (X, last plate Body) are shorter than in the male, and do not pass out of the abdominal cavity, but, on arriving at the margin of the pelvis (22, last plate Body), each artery passes inward between the two laminæ of the broad ligament of the uterus (U, Female Genital Organs) to be distributed to the ovary (O, Female Genital Organs), one or two small branches supplying the Fallopian tube (F, T, Female Genital Organs), another passing on to the side of the uterus and anastomosing with the uterine arteries.

The phrenic arteries are two small vessels which present a great deal of variety in their origin. They may arise separately from the front of the aorta immediately above the cœliac axis, or by a common trunk which may spring from the aorta or from the cœliac axis, or sometimes one is derived from the aorta and the other from one of the renal arteries. They diverge from one another across the crura of the diaphragm, and then pass obliquely upward and outward upon its under surface, the left passing behind the œsophagus, and running forward on the left side of the œsophageal opening, the right passing behind the interior vena cava, and ascending along the right side of the aperture for transmitting that vein.

Near the back part of the central tendon each vessel divides into two branches, the internal branch running forward to the front of the thorax, supplying the diaphragm, and anastomosing with its fellow of the opposite side and with the musculo-phrenic branches of the internal mammary (Breast), the external branch passing the side of the thorax and inosculating with the intercostal arteries. The

internal branch of the right phrenic gives off a few vessels to the inferior vena cava, the left, some branches to the œsophagus, and each vessel sends capsular branches to the supra-renal capsule of its own side, the spleen and the liver.

The lumbar arteries (V, last plate Body), usually four pairs, are analogous to the intercostal, and rise from the back of the aorta nearly at right angles with that vessel. They pass out and back around the sides of the body of the lumbar vertebræ, those on the right being covered by the inferior vena cava (E, last plate Body), and the two upper ones on each side by the crura of the diaphragm. In the interval between the transverse processes of the vertebræ, each artery divides into a dorsal and abdominal branch. The dorsal branch gives off, immediately after its origin, a spinal branch, which enters the spinal canal, continues on its course backward between the transverse processes, and is distributed to the muscles and integument of the back, anastomosing with the similar branches of the adjacent lumbar arteries and with the intercostal branches. It also divides into two branches, one of which ascends on the posterior surface of the body of the vertebræ above, and the other descends on the posterior surface of the vertebræ below. The inosculations of these vessels on each side throughout the whole length of the spine, form a series of arterial arches behind the bodies of the vertebræ, which are connected with each other and with a median longitudinal vessel. The abdominal branches pass outward behind the quadratus lumborum, the lowest branch occasionally in front of that vessel, and, being continued between the abdominal muscles, anastomose with branches of the epigastric and internal mammary in front, the intercostals above, and those of the ilio-lumbar and circumflex iliac below.

The middle sacral artery is a small vessel about the size of a common quill, which arises from the back of the aorta just at its bifurcation, descends at the last lumbar vertebra and along the middle line of the front of the sacrum to the upper part of the coccyx, where it anastomoses with the lateral sacral arteries, and terminates in a middle branch, which runs down to that portion of the body described as Luschka's gland. Other branches are given off on each side which anastomose with the lateral sacral arteries. Luschka's gland lies near the tip of the coccyx, just above the coccygeal attachment of the sphincter, and consists of a congeries of small arteries derived from the middle sacral and freely communicating with each other.

The abdominal aorta divides into the two common iliac arteries (G, last plate body), the bifurcations usually taking place on the left side of the body of the fourth lumbar vertebra, a point corresponding to the left side of the umbilicus (white spot, last plate of Body), and on a level with a line drawn from the highest point of one iliac crest to the other. The common iliac arteries are about two inches in length, diverge from the termination of the aorta, pass downward and outward to the margin of the pelvis, and divide, opposite the intervertebral substance between the last lumbar vertebra and the sacrum, into two branches, the external and the internal iliac arteries, the former supplying the lower extremity, the latter the viscera, and parietes of the pelvis. The right common iliac is somewhat larger than the left, and passes more obliquely across the body of the last lumbar vertebra; in front of it are the peritoneum, the ilium, branches of the sympathetic nerve, and at its point of division, the ureter; while behind it is separated from

the last lumbar vertebra by the two common iliac veins, and on its outer side it is in relation with the interior vena cava, the right common iliac vein above, and the psoas magnus muscle below. The left common iliac is in relation in front with the peritoneum, branches of the sympathetic nerve, and the superior hæmorrhoidal artery, and is crossed at its point of bifurcation by the ureter (24, last plate Body). The common iliac arteries give off small branches to the peritoneum, psoas magnus, ureters, and the surrounding cellular tissue, and occasionally give origin to the renal arteries. The internal iliac artery supplies the walls and viscera of the pelvis (22, back plate Body), the generative organs, and the inner part of the thigh. It is a short, thick vessel, about an inch and a half in length, rising at the point of bifurcation of the common iliac, passing downward to the upper margin of the great sacro-sciatic foramen, and dividing into two large trunks. The internal iliac has twelve branches, a few of which it is necessary to mention. These are the *uterine* artery, or the artery of the womb, the *vaginal* artery, and a few arteries common to both sexes. The uterine artery passes downward from the anterior trunk of the internal iliac to the neck of the uterus, ascending in a tortuous course on the side of the viscera; between the layers of the broad ligament it distributes branches to its substance, anastomosing near its termination with a branch from the ovarian artery, and branches from this vessel are also distributed to the bladder and ureter. The vaginal artery is analogous to the inferior vesical in the male, descends upon the vagina, supplying its mucous membrane, and sends branches to the neck of the bladder and contiguous parts of the rectum.

The obturator artery (last plate Body) usually arises

OPERATOR INJECTING THE SCALP.

(See page 196.)

from the anterior trunk of the internal iliac, passes forward below the brim of the pelvis to the canal in the upper border of the obturator foramen, and, escaping from the pelvic cavity through this aperture, divides into an internal and an external branch. In the pelvic cavity this vessel lies upon the pelvic fascia, beneath the peritoneum, and a little below the obturator nerve, and, while passing through the obturator foramen, is contained in a canal formed by the horizontal branch of the pubes above, and the border of the obturator membrane below. Within the pelvis, the obturator artery gives off a branch of the iliac to the iliac fossa, which anastomoses with the ilio-lumbar artery, a vesical branch, which supplies the bladder, and pubic branch, which is given off before it leaves the pelvic cavity. External to the pelvis, the obturator artery divides into an external and an internal branch, which are both deeply seated beneath the obturator externus muscle, and which anastomose at the lower part of this aperture with each other, and with branches of the internal circumflex artery. The internal branch curves downward along the inner margin of the obturator foramen, distributes branches to three or four muscles, and anastomoses with the external branch and internal circumflex artery; the external branch curves around the outer margin of the foramen obturator to the space between the gemellus inferior and quadratus femoris, where it anastomoses with the sciatic artery, as it passes backward with the internal circumflex; it also sends a branch to the hip joint.

The internal pudic is the smallest of the two terminal branches of the anterior trunk of the internal iliac, and supplies the external organs of generation; it divides finally into two terminal branches, the dorsal artery of the penis and the artery of the corpus cavernosum. It is

accompanied by the pudic veins and nerve. The dorsal artery of the penis ascends between the crus and pubic symphysis, runs forward on the dorsum of the penis to the glans, where it divides into two branches which supply the glans and prepuce. On the dorsum of the penis it lies immediately beneath the integument parallel with the dorsal vein and the corresponding artery of the opposite side.

The sciatic artery, the larger of the two terminal branches of the anterior trunk of the internal iliac, is distributed to the muscles on the back of the pelvis, passes down to the lower parts of the great sacro-sciatic foramen, behind the internal pudic, then descends in the interval between the trochanter major and the tuberosity of the ischium.

The gluteal artery (B, last plate Body) is the largest branch of the internal iliac, and appears to be the continuation of the posterior division of that vessel. It is a short, thick trunk which passes out of the pelvis above the upper border of the pyriformis muscle, and immediately divides into a superficial and deep branch; just before it leaves the cavity of the pelvis it gives off a nutrient artery which enters the ilium. The superficial branch passes beneath the gluteus maximus and divides into many branches. The deep branch runs between the gluteus medius and minimus, and subdivides into the superior and inferior division; the former continues the original course of the vessel, and anastomoses with the cimcumflex iliac and ascending branches of the external circumflex artery; the latter crosses the gluteus minimus obliquely to the trochanter major, and inosculates with the circumflex artery.

The external iliac artery is the chief vessel which sup-

plies the lower limb. It is larger than the internal iliac, and passes downward and outward along the inner border of the psoas muscle from the bifurcation of the common iliac to Poupart's ligament (31, Muscle plate), where it enters the thigh and becomes the femoral artery. At its origin it is crossed by the ureter, and numerous lymphatic vessels are found lying on its front and inner side. Besides several small branches, the external iliac gives off two branches of considerable size, the *deep epigastric* and *deep circumflex iliac.*

The deep epigastric artery arises from the external iliac a few lines above Poupart's ligament, at first descends to reach this ligament, then ascends along the inner margin of the internal abdominal ring, and finally divides into numerous branches which anastomose above the umbilicus with the terminal branches of the internal mammary and inferior intercostal arteries. The deep circumflex artery rises from the outer side of the external iliac, nearly opposite the epigastric artery, ascends obliquely upward behind Poupart's ligament, runs along the inner surface of the crest of the ilium to about its middle, where it pierces the transversalis, and runs backward between that muscle and the internal oblique to anastomose with the iliac, lumbar and gluteal arteries. Opposite the anterior superior spine of the ilium it gives off a large branch, which ascends between the internal oblique and transversalis muscle, supplying them, anastomosing with the lumbar and epigastric arteries.

The femoral artery (A, plate 3, Lower Extremity), the continuation of the external iliac, commences immediately behind Poupart's ligament, midway between the anterior superior spine of the ilium, and the symphysis pubis, and, passing down the fore part and inner side of the thigh,

terminates at the opening in the adductor magnus at the junction of the middle with the lower third of the thigh, where it becomes the popliteal artery. The upper two-thirds of a line drawn from a point midway between the anterior superior spine of the ilium and the spine of the pubis to the inner side of the inner condyle of the femur, with the thigh abducted and rotated so that the foot stands outward, will indicate the course of this artery.

In the upper third of the thigh, the femoral artery is very superficial, and is contained in a triangular space called Scarpa's triangle, which corresponds to the depression seen immediately below the groin fold. The apex of the triangle is directed downward, the sides formed externally by the sartorius muscle, internally by the adductor longus, and above by Poupart's ligament. The floor of this space is formed by the *iliacus*, *psoas*, *pectineus*, *adductor longus*, and a small part of the *adductor brevis muscle*. It is divided into two nearly equal parts by the femoral vessels, which extend from the middle of its base to its apex. The artery in this situation gives off its cutaneous and profunda branches. The branches of the femoral artery are the *superficial epigastric*, *superficial circumflex iliac*, *superficial external pudic*, the *deep external pudic*, and the several *profunda* branches — namely the *external circumflex*, *internal circumflex*, and three *perforating*.

The superior epigastric rises from the femoral about one-half an inch below Poupart's ligament, and, passing through the saphenous opening in the fascia lata, ascends to the abdomen and anastomoses with branches of the deep epigastric and internal mammary arteries; the superficial circumflex iliac (D, back plate Body), the smallest of the cutaneous branches, rises close to the preceding branch, runs outward parallel with Poupart's ligament as

far as the crest of the ilium, and there divides into branches, supplying the fascia and the inguinal glands, and anastomosing with the circumflex iliac (B, back plate Body) and with the gluteal and external circumflex artery; the superficial external pudic rises from the inner side of the femoral artery close to the preceding vessels, and, after passing through the saphenous opening, courses inward across the spermatic cord, to be distributed to the integument on the lower part of the abdomen, the penis and scrotum in the male, and the labium in the female, anastomosing with the branches of the internal pudic; the deep external pudic passes inward on the pectineus muscle, and, covered by the fascia lata, its branches are distributed in the male to the integument of the scrotum and perineum, and in the female to the labium, anastomosing with branches of the superficial perineal artery. The profunda femoris (B, plate 3, Lower Extremity) nearly equal in size to the superficial femoral, rises from the outer and back part of the femoral artery, a little below Poupart's ligament. Lying on the outer side of the superficial femoral, and then passing behind it and the femoral vein to the inner side of the thigh bone, it terminates in a small branch in the lower third of the thigh. The external circumflex artery (L, back plate Body) supplies the muscles on the front of the thigh, and, rising from the outer side of the profunda, passes outward in a horizontal direction, and divides into three sets of branches — *ascending*, *transverse*, and *descending*. The internal circumflex artery (F, back plate Body) rises from the inner and back part of the profunda, and winds around the inner side of the femur. On reaching the upper border of the adductor brevis, it gives off two branches, one of which passes inward, anastomosing with the obturator artery;

the other descends and passes beneath the adductor brevis to supply it and the great adductor, while the continuation of the vessel passes backward between the quadratus femoris and upper border of the adductor magnus, anastomosing with the sciatic external circumflex, and superior perforating arteries. The perforating arteries, usually three in number, are so called from their perforating tendons of the adductor brevis and magnus muscle.

The popliteal artery (F, plate 6, Upper Extremity) commences at the termination of the femoral, at the opening in the adductor magnus, and, passing downward and outward behind the knee joint to the lower border of the popliteal muscle, divides into the *anterior* and *posterior tibial* arteries (G, lower part plate 5, Lower Extremity), and through the whole of its extent lies in the popliteal space.

The popliteal space (H, plate 5, Lower Extremity) occupies the lower third of the thigh and the upper fifth of the leg, extending from the aperture in the adductor magnus to the lower part of the popliteal muscle; it is shaped like a lozenge, being widest at the back part of the knee joint, and deepest above the articular end of the femur. Its floor is formed by the lower part of the posterior surface of the shaft of the femur, the posterior ligament of the knee joint, the upper end of the tibia, and the fascia covering the popliteal muscle; the space is covered in by the fascia lata. It contains the popliteal vessels and their branches, the termination of the external saphenous vein, the internal and external popliteal nerves and their branches, the small sciatic nerve, a few small lymphatic glands and a quantity of tissue.

There are many branches given off by the popliteal artery, of which we will mention but three; the *cutaneous*

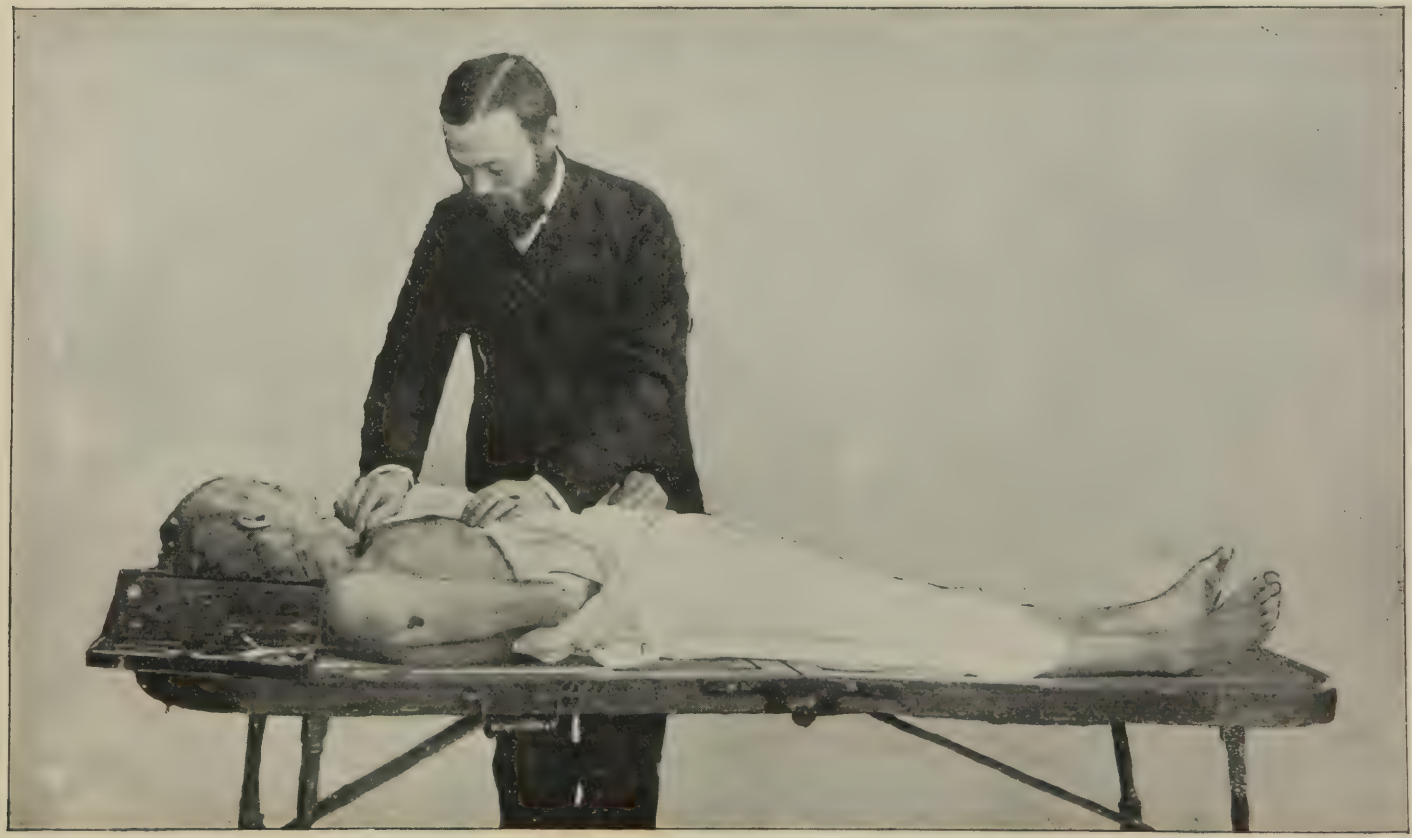
branches (f, plate 6, Lower Extremity), the *superior articular arteries* and the *inferior articular arteries*. The cutaneous branches descend on each side, and in the middle of the limb rise separately from the popliteal artery and supply the integument of the calf of the leg. The superior articular arteries (plate 4, Lower Extremity) are two in number, and rise one on each side of the popliteal, and wind around the femur, immediately above its condyles, to the front of the knee joint; the superficial branch supplies the vastus externus, and anastomoses with a descending branch of the external circumflex artery. The inferior articular arteries (plate 4, Lower Extremity) are also two in number, and rise from the popliteal beneath the gastrocnemius, and wind around the head of the tibia (1, lower part plate 5, Lower Extremity) below the joint, the internal branch passes below the inner tuberosity, beneath the internal lateral ligament, at the anterior border of which it ascends to the front and inner side of the joint to supply the head of the tibia and the articulation of the knee; the external branch passes outward above the head of the fibula to the front of the knee joint, and divides into branches which anastomose with the inferior internal articular artery, the superior articular arteries, and the recurrent branch of the anterior tibial.

The anterior tibial artery (Q, plate 5, Lower Extremity) commences at the bifurcation of the popliteal at the lower border of the popliteus muscle, passes forward between the two heads of the tibialis posticus, and through the aperture left between the bones at the upper part of the interosseous membrane to the deep part of the front of the leg; it then descends on the anterior surface of the tibia to the bend of the ankle joint, where it lies more superficially and becomes the dorsalis pedis. A line drawn from the inner

side of the head of the fibula to midway between the two malleoli will mark the course of the artery, the point where it comes in front of the interosseous membrane being in this line one and a quarter inches below the level of the head of the fibula. Or, if the foot is turned so as to loosen the muscles, the artery is then exposed deeply seated.

The branches of the anterior tibial artery are the *recurrent tibial* (B, lower part plate 5, Lower Extremity), *muscular*, *internal malleolar*, and *external malleolar*. The recurrent branch rises from the anterior tibial as soon as that vessel has passed through the interosseous space, and anastomoses with the articular branches of the popliteal artery; the muscular branches are many, and are distributed to the muscles which lie on either side of the vessel, many of them anastomosing with the branches of the posterior tibial and peroneal arteries (H, lower part plate 5, Lower Extremity); the malleolar branches supply the ankle joint, the internal rising about two inches above the articulation, and passing beneath the tendons of the extensor proprius pollicis and tibialis anticus, to the inner ankle, upon which it ramifies, anastomosing with branches of the posterior tibial and internal plantar arteries (L, lower part plate 5, Lower Extremity); the external passes beneath the tendons of the extensor longus digitorum and peroneus tertius, and supplies the outer ankle, anastomosing with the anterior peroneal arteries.

The dorsalis pedis artery (A, lower part plate 5, Lower Extremity), the continuation of the anterior tibial, passes forward from the bend of the ankle, along the foot to the back of the first interosseous space, where it divides in two branches. This vessel in its course forward rests upon the astragalus, scaphoid and internal cuneiform bones, and is covered by the fascia; on its fibular side is the termination



OPERATOR RAISING THE CAROTID ARTERY.

(See page 90.)

of the anterior tibial nerve, and it is accompanied by two veins. The branches of the dorsalis pedis artery are the *tarsal* (D, lower part plate 5, Lower Extremity), the *metatarsal* (E, lower part plate 5, Lower Extremity), the *interosseous*, the *dorsalis hallucis*, and the *communicating*. The tarsal artery rises from the dorsalis pedis, as that vessel crosses the scaphoid bone, passes in an arched direction outward, and, lying upon the tarsal bone, it anastomoses with branches from the metatarsal, external malleolar and external plantar arteries; the metatarsal rises a little in front of the preceding, passes outward to the outer part of the foot over the bases of the metatarsal bones, and anastomoses with the tarsal and external plantar arteries (M, lower part plate 5, Lower Extremity). The outermost interosseous artery gives off a branch which supplies the outer side of the little toe. The dorsalis hallucis (F, lower plate 5, Lower Extremity) runs forward along the outer border of the first metatarsal bone, at the cleft between the first and second toes divides into two branches, one of which passes inward and is distributed to the inner border of the great toe, the other branch bifurcates to supply the adjoining sides of the great and second toes; the communicating artery dips down into the sole of the foot and inosculates with the termination of the external plantar artery to complete the plantar arch; it here gives off two digital branches, one running along the inner side of the great toe on its plantar surface, the other passing forward along the first metatarsal space, where it bifurcates to supply the adjacent sides of the great and second toes.

The posterior tibial artery (G, lower part plate 5, Lower Extremity) is of large size, and extends obliquely downward from the lower border of the popliteus muscle, along the tibial side of the leg, to the inner ankle and

heel, where it divides beneath the origin of the abductor pollicis into the internal and external plantar arteries. At its origin it lies opposite the interval between the tibia (1, plate 5) and fibula (4, plate 5), and, as it descends, approaches the inner side of the leg, lying behind the tibia. In the lower part of its course, it is situated midway between the inner malleolus (3, plate 5) and the os calcis. It is more superficial at its lower third, being covered by the integument and fascia only, and runs parallel with the tendo Achillis. It is accompanied by two veins and by the tibial nerve, which in the greater part of its course is situated on its outer side.

VEINS.

(Plate, Blood Formation.)

The veins are the vessels which serve to convey the blood from the capillaries of the different parts of the body to the heart, and, like the arteries, they are found in nearly all the tissues of the body. They commence by minute plexuses which receive the blood from the capillaries, communicate freely with each other, and in form are not cylindrical, as are the arteries, their walls being thinner, and collapsed when they are empty. They are larger and more numerous than the arteries, and, with the exception of the pulmonary veins (17), which do not in capacity exceed the pulmonary arteries (5), the entire capacity of the venous system is decidedly greater than the arterial.

Like the arteries, the veins consist of two separate and distinct systems, the pulmonary and systemic. The pulmonary veins, unlike other vessels of this kind, contain arterial blood, which they return from the lungs to the left auricle (26) of the heart. The systemic veins are con-

cerned in the general circulation, and return the venous blood from the body to the right auricle (25) of the heart. The portal vein (23), an appendage to the systemic venous system, is confined to the abdominal cavity, returning venous blood from the viscera of digestion, and carrying it to the liver (32) by a single trunk of extra size, the vena porta (23). This vessel ramifies in the substance of the liver, and breaks up into a minute network of capillaries, which then reunite to form the hepatic veins (19), by which the blood is conveyed to the inferior vena cava (18).

The systemic veins are subdivided into three sets, *i.e.*, the *superficial* or *subcutaneous* veins, the *deep* veins and the *sinuses*. The superficial veins are found immediately beneath the integument, between the layers of the superficial fascia, and communicate with the deep veins by perforating the deep fascia. The deep veins have thinner coats, always accompany the arteries, and are usually in the same sheath. The larger arteries have usually but one accompanying vein; but in the smaller arteries they exist in pairs, lying on each side of the artery, and are called the venæ comites. Sinuses are venous channels which differ entirely from the veins. In the lower limbs the veins are much thicker than in the upper.

THE PULMONARY VEINS.

(See Plate, Blood Formation.)

There are four pulmonary veins (17), each lung having two, and their office is to convey the arterial blood from the lungs to the left auricle (26) of the heart. They differ from other veins in many respects; first, they carry arterial instead of venous blood; second, they have no valves; third, they are only slightly larger than the arteries,

which they accompany; fourth they accompany those arteries singly. They commence in the capillary network upon the walls of the air-cells, where they are continuous with the ramifications of the pulmonary artery (5), and, uniting together, they form a single trunk for each lobule. Within the lung, the pulmonary artery (5) branches are in front, the veins behind, and the bronchi between the two; at the root of the lung, the veins are in front, the artery in the middle, and the bronchi behind.

THE SYSTEMIC VEINS.

The systemic veins may be arranged into three groups: First, those of the head, neck, upper extremities, and thorax; second, those of the lower extremities, pelvis, and abdomen, which terminate in the inferior vena cava (18); third, the cardiac veins, which open directly into the right auricle (25) of the heart.

The veins of the head and neck (see Head plate) may be subdivided into three groups: first, those of the exterior of the head; second, those of the neck; third, those of the diploë and interior of the cranium.

The veins of the exterior of the head are the *facial*, (17, Head plate), the *temporal* (18), the *internal maxillary* (35), the *temporo-maxillary*, the *posterior-auricular*, and the *occipital*. The facial vein (17) crosses obliquely the side of the face, is on the outer side of the facial artery (20), and is not so tortuous as that vessel. The frontal vein commences on the anterior portion of the skull by a venous plexus, and communicates with the anterior tributaries of the temporal vein (18); occasionally the frontal veins join to form a single trunk, which bifurcates or branches at the root of the nose into the two angular veins. The temporal vein commences by a minute plexus

on the side of the skull, and communicates with the frontal vein in front. The internal maxillary vein is quite large, and receives branches which correspond with branches of the internal maxillary artery; it receives several small veins, together forming a plexus of large size, which communicates very freely with the facial vein (17). The temporo-maxillary vein is formed by the union of the temporal (18) and internal maxillary vein (35). It descends in the substance of the parotid gland, on the outer surface of the external carotid artery (1, Blood Formation), between the jaw and the sterno-mastoid muscle, and divides into two branches; one passes inward and joins the facial vein (17), the other is joined by the posterior auricular vein and becomes the external jugular (16, Blood Formation). The posterior auricular vein commences on the side of the head by a plexus, which communicates with the tributaries of the temporal and occipital veins; it descends behind the ear, and joins the temporo-maxillary vein, thus forming the external jugular vein. The occipital veins are three in number. They commence at the back part of the skull by a plexus, follow the course of the occipital artery, and usually terminate in the internal jugular vein, though sometimes their termination is found in the external jugular vein.

The veins of the neck, which return the blood from the head and face, are the *external jugular* (16, Head plate), the *anterior jugular*, the *posterior external jugular*, the *internal jugular* and the *vertebral* vein. The external jugular vein receives the greater part of the blood from the exterior of the cranium and deep parts of the face. It commences in the substance of the parotid gland, on a level with the angle of the lower jaw, and runs perpendicularly down the neck in the direction of a line drawn from

the angle of the jaw to the middle of the clavicle (13, Skeleton plate). It then crosses the sterno-mastoid muscle, and runs parallel with its posterior border as far as its attachment to the clavicle, where it perforates the deep fascia and terminates in the subclavian vein (15, Blood Formation). The external jugular vein varies in size, and is sometimes found double. It has two pairs of valves, the lower situated at its entrance into the subclavian vein, the upper about one or two inches above the clavicle. These valves do not prevent the regurgitation of the blood or the passage of an injection from below upward. The posterior external jugular vein returns the blood from the integument and superficial muscles in the upper and back part of the neck; it runs down the back part of the neck, and opens into the external jugular vein just below the middle of its course. The anterior jugular vein, or veins, for most frequently there are two, commence near the hyoid bone (19, Body plate), and pass down between the median line and the anterior border of the sterno-mastoid (18, Body plate). These veins vary extremely in size, and communicate with the jugular veins. They have no valves, and consequently can be injected. The internal jugular vein collects the blood from the interior of the cranium, from the superficial parts of the face, and also from the neck. It commences just externally to the jugular foramen, in the base of the skull, runs down the side of the neck in a vertical direction, lying at first on the outer side of the internal carotid, and then on the outer side of the common carotid arteries (19, Head plate). At the root of the neck it unites with the subclavian vein to form the vena innominata (14, Blood Formation); this vein is sometimes quite large, and is provided with one pair of valves, which usually are at its termination, though sometimes

they are placed a little above. The vertebral vein commences in the occipital region by numerous small tributaries from the deep muscles at the upper and back part of the neck, passes outward and enters the foramen in the transverse process of the atlas; descends by the side of the vertebral artery in the canal formed by the transverse processes of the cervical vertebræ, emerges from the foramen in the transverse processes of the six cervical vertebræ, and terminates at the root of the neck in the back part of the innominate vein (14, Blood Formation). Near its origin its mouth is guarded by one pair of valves. On the right side it crosses the first part of the subclavian artery (3, Blood Formation).

THE SUPERFICIAL VEINS OF THE UPPER EXTREMITY.

(See plate, Upper and Lower Extremities.)

The superficial veins are placed immediately beneath the integument between the two layers of superficial fascia, and commence in the hand, chiefly on its dorsal aspect, where they form a more or less complete arch. They are, namely, the *anterior ulnar*, *posterior ulnar*, *radial*, *median*, *median basilic*, *median cephalic basilic*, and *cephalic*.

The anterior ulnar vein commences on the anterior surface of the ulnar side of the hand and wrist, and continues its course along the inner or ulnar side of the forearm to the bend of the elbow, where it joins with the posterior ulnar vein to form the basilic; occasionally, it opens in the median basilic vein. The posterior ulnar vein commences on the posterior surface of the ulnar side of the hand, and from the vein of the little finger (the vena salvatella), it runs on the posterior surface on the ulnar side of the forearm, and, just below the elbow, unites with the anterior ulnar

vein to form the basilic vein. Sometimes it joins the median basilic (5) to form the basilic vein, (II.) and it also communicates by a branch with the deep veins of the palm. The common ulnar vein is a short trunk which is not constant; when it does exist, it is formed by the junction of the two preceding veins. The radial vein (III.) commences from the dorsal surface of the thumb, index finger, and radial side of the hand, communicates with the vena salvatella and with the deep veins of the palm by a branch which passes through the first interosseous space; at the bend of the elbow it unites with the median cephalic to form the cephalic vein, (III.) The median vein (IV.) collects the blood from the superficial structures on the palmar surface of the hand and median line of the forearm, and, communicating with the anterior radial and ulnar veins at the bend of the elbow, it receives a branch of communication from the deep veins accompanying the brachial artery (A), and divides into two branches, which diverge from each other as they ascend. The median basilic vein (V.) passes inward in the groove of the biceps muscle, and joins the common ulnar to form the basilic vein; it passes in front of the brachial artery, and is separated from it by the bicipital fascia. The basilica vein (II.) is very large, and, formed by the common ulnar vein with the median basilic, it passes upward along the line of the biceps muscle on the inner side, and ascends in the course of the brachial artery (A). The cephalic vein (III.) courses along the outer border of the biceps muscle to the upper third of the arm; it then passes in the interval between the pectoralis major and deltoid muscles, and terminates in the axillary vein just below the clavicle; this vein is sometimes connected with the

external jugular or subclavian by a branch which passes from it upward in front of the clavicle.

THE DEEP VEINS OF THE UPPER EXTREMITY.

(Same plate.)

The deep veins of the upper extremities follow the course of the arteries, forming their venæ comites. These are two in number, one lying on each side of the corresponding artery, and are connected by short transverse branches a little distance apart. There are two digital veins accompanying each artery along the sides of the fingers, and there, uniting at their base, they pass along the spaces into the palm of the hand, and terminate in the two venæ comites, which accompany the superficial palmar arch. The deep ulnar veins, as they pass in front of the wrist, communicate with the interosseus and superficial veins, and at the elbow unite with the deep radial veins, to form the venæ comites of the brachial artery (A). The interosseous veins accompany the anterior and posterior interosseous arteries; the anterior interosseous veins commence in the front of the wrist, where they communicate with the deep radial and ulnar veins, and terminate in the venæ comites of the ulnar artery (G, Sec. 4). The deep palmar veins accompany the deep palmar arch, communicate with the superficial palmar veins at the inner side of the hand, and on the outer side terminate in the venæ comites of the radial artery (B, section 2). At the wrist they receive branches which unite with the deep radial vein, as they are in company with the radial artery, and terminate in the venæ comites of the brachial artery (A, section 2). The brachial veins (V, section 2) are situated one on either side of the brachial artery. At the lower margin of the axilla they unite with the basilic

to form the axillary vein. All the deep veins have many anastomoses, not only with each other, but with many of the superficial veins.

VEINS OF THE SHOULDER AND CHEST.

The axillary vein is of large size, and is formed by the junction of the venæ comites of the brachial artery with the basilic vein. It begins at the lower part of the axillary space, increases in size as it ascends by receiving tributaries corresponding with the branches of the axillary artery, and terminates immediately beneath the clavicle, at the outer margin of the first rib, where it becomes the subclavian vein. Near its termination it receives the cephalic vein. The subclavian vein (5, Blood Formation) is the continuation of the axillary. It extends from the outer margin of the first rib to the inner end of the sterno-clavicular articulation, where it unites with the internal jugular to form the innominate veins (14, Blood Formation). It occasionally rises in the neck to a level with the third part of the subclavian artery (3, Blood Formation). The innominate veins are two large trunks (14, Right and Left), laid one on each side of the root of the neck, and formed by the union of the internal jugular and subclavian veins of the corresponding side. There is but one innominate artery (3, Blood Formation). The right innominate vein is short, about one and one-half inches in length, commences at the inner end of the clavicle, and, passing downward, joins the left vena innominata just below the first rib, near the right border of the sternum, forming the superior vena cava (13, Blood Formation). It is superficial and external to the arteria innominata. The left innominate vein is about three inches in length, and larger than the right. It passes from left to right across the

chest, inclines downward to unite with its fellow of the opposite side, thus forming the superior vena cava. The internal mammary veins are two in number to each artery, and follow the course of the artery of the same name. The superior intercostal veins return the blood from the upper intercostal spaces. The right vein is much smaller than the left, and corresponds with the superior intercostal artery. The left superior intercostal vein varies in size, being smaller when the left upper azygos vein is large, and *vice versa*. The superior vena cava (13, Blood Formation) receives the blood which is conveyed to the heart from the whole of the upper half of the body, and also the contents of the right lymphatic (37, Blood Formation) and thoracic ducts (29, Blood Formation). It is a short, valveless trunk, varying from two inches and a half to three inches in length, and is formed by the junction of the two venæ innominatæ. It enters the pericardium about one inch and a half above the heart, and terminates in the upper part of the right auricle. Just before it enters the pericardium it receives the vena azygos major (13, Blood Formation). The azygos veins connect the superior and inferior venæ cavæ, supplying the place of those vessels in the part of the chest which is occupied by the heart. The right, or larger azygos vein — azygos major — (1, rear section of Body plate) begins opposite the first or second lumbar vertebra by a branch from the right lumbar veins, and sometimes by a branch from the inferior vena cava. It enters the thorax through the aortic opening in the diaphragm, passes along the right side of the vertebral column, and terminates in the superior vena cava, just before that vessel enters the pericardium. In the thorax, it lies upon the intercostal arteries on the right side of the

aorta. The left or smaller azygos vein (azygos minor) begins in the lumbar region by a branch from one of the lumbar veins, passes into the thorax through the left crus of the diaphragm, ascends on the left side of the spine as high as the sixth or seventh dorsal vertebra, and terminates in the right azygos vein. The bronchial veins return the blood from the substance of the lungs, the right vein opening into the vena azygos major, the left into the left superior intercostal vein.

THE SPINAL VEINS.

The spinal veins are arranged in four sets: the *dorsi-spinal* veins, or those situated on the exterior of the spinal column; the *meningo-rachidian* veins, or those situated in the interior of the spinal canal; the *venæ bases vertebrarum*, or the veins of the bodies of the vertebræ ; the *medulli-spinal*, or the veins of the spinal cord.

The dorsi-spinal veins commence by small branches which receive their blood from the back of the spine and from the muscles in the vertebral grooves. They form a network which surrounds the spinous process, the laminæ, and the transverse and articular processes of all the vertebræ. They terminate by joining the vertebral veins in the neck, the intercostal veins in the thorax, and the lumbar and sacral veins in the loins and pelvis.

The meningo-rachidian veins, the principal veins contained in the spinal canal, are situated between the theca vertebralis and the vertebræ, and are two in number, the anterior longitudinal spinal vein, and the posterior longitudinal spinal vein. The anterior longitudinal spinal vein consists of two large tortuous venous canals which extend along the whole length of the vertebral column from the foramen magnum to the base of the coccyx (26, Skeleton

plate); the posterior longitudinal spinal veins are smaller than the anterior, and are situated one on either side between the inner surfaces of the laminæ and the theca vertebralis. Like the anterior veins, they communicate opposite each vertebra by transverse trunks.

The veins of the bodies of the vertebræ emerge from the foramina on their posterior surface, and join the transverse trunk connecting the anterior longitudinal spinal veins. In advanced age they become greatly developed.

The veins of the spinal cord are valveless, and consist of a tortuous venous plexus which covers the entire surface of the cord, and is situated between the pia mater and arachnoid. Near the base of the skull these veins unite and form several small trunks, which communicate with the vertebral veins, and there terminate in the interior cerebellar veins. There are no valves in the spinal veins, and, as a consequence, they get thoroughly injected with the fluid.

THE SUPERFICIAL VEINS OF THE LOWER EXTREMITY.

(See plate, Upper and Lower Extremity.)

The veins of the lower extremity are more fully supplied with valves than those of the upper, and are divided into two sets, superficial and deep. The superficial veins are placed beneath the integument between the two layers of superficial fascia; and are subdivided into the *internal* or *long saphenous*, and the *external* or *short saphenous veins*. The internal or long saphenous vein (1, Sec. 1) is very easily seen. It commences at the inner side of the arch on the dorsum of the foot, ascends in front of the inner malleolus and along the inner side of the leg; at the knee it passes backward behind the inner condyle of the femur, or thigh bone (1, Sec. 4), then ascends along

the inside of the thigh, and terminates in the femoral vein (1, plate 2 and 3, Leg) about one inch and a half below Poupart's ligament. This vein (1, Sec. 1, Leg) communicates in the foot with the internal plantar vein, in the leg with the posterior tibial veins, at the knee with the articular veins, and in the thigh with the femoral vein. It possesses from two to six valves, more numerous in the thigh than in the leg. The external or short saphenous vein commences at the outer side of the arch on the dorsum of the foot, ascends behind the outer malleolus, and along the outer border of the tendo Achilles, passes directly upward, and terminates in the popliteal vein. Before it perforates the deep fascia, it gives off a communicating branch, which passes upward to join the internal saphenous vein. It also has a number of valves, one of which is always found at its termination in the popliteal vein.

THE DEEP VEINS OF THE LOWER EXTREMITY.

(See plate, Upper and Lower Extremity.)

The deep veins of the lower extremity accompany the arteries and their branches, and are called the venæ comites of these vessels. They are more fully supplied with valves than the superficial veins, and are largely subdivided. The external and internal plantar veins (F, plate 5, Leg and Foot) unite to form the posterior tibial veins, which accompany the posterior tibial artery, and are joined by the peroneal veins. The anterior tibial veins are formed by a continuation upward of the venæ comites of the dorsalis pedis artery (A, plate Leg). They pass between the bones of the leg, tibia and fibula, and form, by their junction with the posterior tibial (plate 5, Lower Extremity), the popliteal vein (plate 5, Lower Extremity).

The popliteal vein is formed by the junction of the venæ comites of the anterior and posterior tibial vessels, ascends through the popliteal space, and becomes the femoral vein (plate 5, Lower Extremity). In this vein there are usually four valves, and in the lower part of its course it is placed internal to the artery.

The femoral vein possesses four or five valves, and accompanies the femoral artery through the upper two-thirds of the thigh, in its lower course lying on the outside, and higher up back of the artery. Near its termination it is joined by the profunda femoris vein, and again, about one and one-half inches below Poupart's ligament, by the internal saphenous vein.

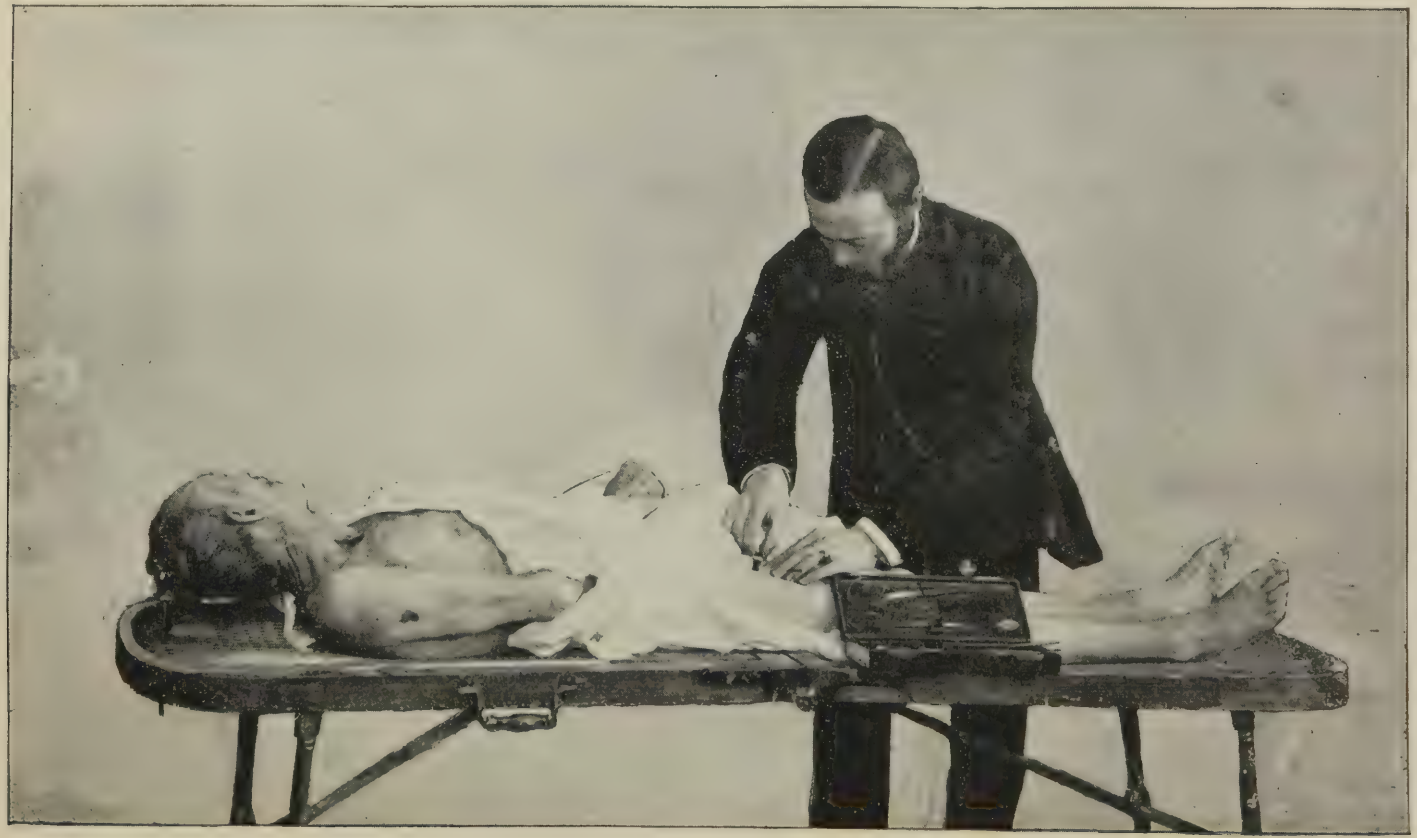
ABDOMINAL VEINS.

The external iliac vein (F, back plate Body) commences at the termination of the femoral vein, beneath the crural arch, passes upward and terminates opposite the sacro-iliac symphysis by uniting with the internal iliac (F, back plate Body) to form the common iliac vein (G, back plate Body). The internal iliac vein (F, back plate Body) is formed by the venæ comites of the branches of the internal iliac artery (F, back plate Body), and lies at first on the inner side and then behind the internal iliac artery. It terminates opposite the sacro-iliac articulation by uniting with the external iliac to form the common iliac vein. This vessel has no valves. The dorsal vein of the penis (plate, Male Genital Organs) is a vessel of large size, which returns the blood from the body of that organ. The common iliac veins (G, back plate Body) are formed by the union of the external and internal iliac veins in front of the sacro-vertebral articulation. Passing upward toward the right side, they terminate upon the intervertebral sub-

stance between the fourth and fifth lumbar vertebræ (12, Skeleton plate), where the veins of the two sides unite at an acute angle to form the inferior vena cava (E, back plate Body). The right common iliac vein is shorter than the left, and ascends behind and then to the outer side of its corresponding artery. The left common iliac vein (G, back plate Body) is more oblique in its course, and is situated at first on the inner side of its corresponding artery, and then behind the right common iliac artery. No valves are found in these veins.

The inferior vena cava (E, back plate Body) returns to the heart the blood from all the parts below the diaphragm. It is formed by the junction of the two common iliac veins (G, back plate Body), passes upward along the front of the spine on the right side of the aorta (A, back plate Body), then through a groove under the liver, and, perforating the tendinous center of the diaphragm, enters the pericardium, and terminates in the lower part of the right auricle of the heart. At its termination in the auricle, it is provided with a valve called the Eustachian valve.

The renal veins (W, back plate Body) are of large size, and are placed in front of the renal artery (V, back plate Body). The left is longer than the right, and, passing in front of the aorta, just below the origin of the superior mesenteric artery (Y, back plate Body), it opens a little above the right into the vena cava (E, back plate Body). The supra-renal veins terminate on the right side in the vena cava, and on the left side in the left renal or phrenic vein. The phrenic veins, two superior and two inferior, follow the course of the phrenic arteries. The hepatic veins (19, Blood Formation), three in number, commence in the substance of the liver, in the capillary terminations



OPERATOR RAISING THE FEMORAL ARTERY.

(See page 87.)

of the portal vein (23, Blood Formation). They run singly, and have no valves.

THE PORTAL VENOUS SYSTEM.

The portal venous system is composed of four large veins which collect the venous blood from the viscera of digestion. The trunk formed by their union — the vena porta (23, Blood Formation) — enters the liver, ramifies throughout its substance and its branches, and emerges from that organ as the hepatic veins (19, Blood Formation), which terminate in the inferior vena cava (18, Blood Formation).

The branches of these veins are in all cases single, and destitute of valves. The veins forming the portal system are *the inferior mesenteric* (22, Blood Formation), *the superior mesenteric* (22, Blood Formation), *the splenic* (21, Blood Formation), and *the gastric* (20, Blood Formation). The inferior mesenteric vein returns the blood from the rectum, sigmoid flexure (14, Intestine plate), and the descending colon (14, Intestine plate). The superior mesenteric vein returns the blood from the small intestines, the cæcum, and ascending and transverse portions of the colon, corresponding with the distribution of the branches of the superior mesenteric artery.

The splenic vein (21, Blood Formation) commences by five or six large branches which return the blood from the substance of the spleen; these unite and form a single vessel, which passes from left to right behind the upper border of the pancreas (19, back plate Body) below the artery, and terminates at its greater end by uniting at a right angle with the superior mesenteric vein to form the vena porta. The splenic vein is large, and not tortuous like the artery. The gastric veins (20, Blood Formation)

are two in number: one, a small vein, corresponds to the pyloric branch of the hepatic artery (8, Blood Formation); the other, much larger, corresponds to the gastric artery (7, Blood Formation). The former, pyloric, runs along the lesser curvature of the stomach toward the pyloric, receives branches from the pylorus (4, Stomach) and duodenum (5, Stomach), and ends in the vena porta. The latter, coronary, begins near the pylorus, runs along the lesser curvature of the stomach, and then curves downward between the folds of the lesser omentum to end in the vena portae (23, Blood Formation). The portal vein is formed by the junction of the superior mesenteric and splenic veins, their union taking place in front of the vena cava (18, Blood Formation), and behind the upper border of the great end of the pancreas. The portal vein is about four inches in length, and lies behind the hepatic duct and artery—the former to the right, the latter to the left. Within the liver the portal vein receives the blood from the branches of the hepatic artery.

THE CARDIAC VEINS.

The cardiac veins are the veins which return the blood from the substance of the heart, and are, namely, the *great cardiac* vein, the *middle cardiac* vein, the *posterior cardiac* vein, the *anterior cardiac* veins, the right or *small cardiac* vein, and the *vena Thebesii*. The great cardiac vein (Heart) — coronary — is a vessel of considerable size which commences at the apex of the heart, and ascends along the anterior interventricular groove to the base of the ventricles (Heart). The middle cardiac vein commences by small tributaries at the apex of the heart, ascends along the posterior interventricular groove to the base of the heart, and

terminates in the coronary sinus. Its orifice is guarded by a valve.

The posterior cardiac veins are four small vessels which collect the blood from the posterior surface of the left ventricle (Heart), and open into the lower border of the coronary sinus. The anterior cardiac veins (Heart) are three small vessels which collect the blood from the anterior surface of the right ventricle (Heart), and open separately in the lower part of the right auricle (Heart). The right or small coronary vein (Heart) runs along the groove between the right auricle (Heart) and ventricle (Heart) to open into the right extremity of the coronary sinus. It receives blood from the back part of the right auricle (Heart) and ventricle (Heart). The venæ Thebesii are many minute veins which return the blood directly from the muscular substance without entering the venous current. They open by minute orifices on the inner surface of the right auricle (Heart). The coronary sinus is that portion of the great cardiac vein which is situated in the posterior part of the left auriculo-ventricular groove. It is about one inch in length, presents considerable dilatation, and receives the veins enumerated above. The coronary sinus terminates in the right auricle (Heart), its orifice being guarded by the coronary valve. All these vessels are provided with valves. The description given here of the veins will serve our purpose in the art of embalming, and it is unnecessary for us to go into further details.

THE BRAIN AND ITS MEMBRANES.

(See Head section in Aid.)

The brain is that portion of the cerebro-spinal axis contained in the cranial cavity. It is divided into four princi-

pal parts, named the medulla oblongata (30), the pons Varolii, the cerebellum (28), and the cerebrum (27). The medulla oblongata extends from the lower border of the pons to the upper part of the spinal cord, with which it is continuous. The pons is that part of the brain which rests upon the upper portion of the basilar process (58) and body of the sphenoid bone. The cerebellum, the little or after brain, is situated in the inferior pair of occipital fossæ. It consists both of gray and white matter, and its outer surface has a foliated appearance, due to its subdivision by numerous fissures. The cerebrum forms the largest portion of the brain, and lies above both the pons and cerebellum. It is composed both of gray and white matter, is ovoid in shape, is subdivided into hemispheres, and its surface presents a series of convolutions, separated from each other by fissures. Of these, the five principal fissures are the great longitudinal fissure, separating the hemispheres, and the fissure of Sylvius, the fissure of Rolando, and the parieto-occipital fissure, which separates the lobes of the brain. The membranes of the brain are the dura mater, the arachnoid, and the pia mater. The dura mater is a thick, inelastic fibrous membrane, which lines the interior of the skull, its numerous arteries being distributed to the bone. The arachnoid—so named from its resemblance to a spider's web—is a delicate, transparent membrane, which loosely envelopes the brain, its structure consisting of bundles of white, fibrous and elastic tissue intimately blended. It lies between the dura and pia mater. The pia mater is a vascular membrane closely investing the whole outer surface of the brain and dipping into the fissures.

THE PHARYNX.

The pharynx (50, Head plate) is that part of the alimentary canal which is situated behind the nose, mouth and larynx (56, Head Plate).

It is conical in form, its base upward and apex downward, is about four and a half inches in length, and broader in its transverse than in its antero-posterior diameter. Below, it is continuous with the œsophagus (57). The pharynx is composed of three coats, mucous, fibrous and muscular; the fibrous coat, situated between the mucous and muscular layers, is called the pharyngeal aponeurosis.

THE ŒSOPHAGUS.

(See 57, Head plate in Aid.)

The œsophagus, or gullet (57), is a muscular canal about nine inches in length, extending from the pharynx (50) to the stomach.

It passes through the diaphragm, and, entering the abdomen, terminates at the cardiac orifice of the stomach (3, plate of stomach), opposite the ninth dorsal vertebra. The œsophagus has three coats, an external or muscular, a middle or areolar, and an internal or mucous coat.

THE THORAX.

The thorax is a conical framework, made up partly of bones, and partly of soft tissues connecting them. It is narrow above, broad below, flattened before and behind; is bounded in front by the sternum, the six upper costal cartilages, the ribs and intercostal muscles; at the sides by the ribs and the intercostal muscles, and behind by the dorsal vertebra column. The superior opening of the thorax is bounded on each side by the first rib, in front by the upper part of the sternum (6), and behind by the

first dorsal vertebra. It is broader from side to side than from before backward, its direction being forward and upward. The lower opening or base is bounded in front by the cusiform cartilage, behind by the last dorsal vertebra, and on each side by the last rib, the diaphragm filling in the intervening space. Passing through the upper opening of the thorax are the sterno-hyoid and sterno-thyroid muscles, the trachea (24, Head), the œsophagus (57), the thoracic duct (29, Blood Formation), and the longus colli muscles of each side; at the sides the arteria innominata (2, Blood Formation), the left common carotid (1, Blood Formation), left subclavian arteries (3, Blood Formation), and many other smaller parts. The apex of each lung, covered by the pleura, also projects through this aperture a little above the margin of the first rib. The viscera contained in the thorax are the heart, inclosed in the pericardium; and the lungs, invested by the pleura.

THE HEART.

(Body Section of Aid, also Blood Formation.)

The heart is a hollow muscular organ of a conical form, placed between the lungs, and inclosed in the cavity of the pericardium. The pericardium is a conical membranous sac, which, with the inclosed heart and the commencement of the great vessels, lies behind the sternum (6, Body plate), its apex upward, its base attached to the central tendon. Externally, the pericardium is a strong fibrous membrane. The position of the heart in the chest is oblique, its base directed upward and to the right, its apex directed downward, forward, and a little to the left. It is placed behind the lower two-thirds of the sternum, and projects farther into the left cavity of the chest than into the right. Its anterior surface is round and convex, its posterior flattened

and resting upon the diaphragm; the right border is thin and sharp, the left border short, but thick and round. In the adult, the heart measures five inches in length, three and one-half inches in breadth at broadest part, and two and one-half inches in thickness; its average weight in the male is ten ounces, in the female about eight ounces. The heart is subdivided, by a longitudinal muscular septum, into lateral halves, which are named, from their position, the right and the left. A transverse constriction divides each half of the organ into two cavities, the upper cavities on each side being called the auricles, and the lower cavities the ventricles. The right auricle (25, Blood Formation) receives the blood from all parts of the body by the ascending (18, Blood Formation) and descending (13, Blood Formation) venæ cavæ, and forces it through the auriculo-ventricular orifice (8, Body Section) into the ventricles for its entrance into the pulmonary artery (5, Blood Formation), so that in its passage through the lungs the blood becomes oxidized or aërated before its entrance into the left side of the heart for its final distribution throughout the general system. The right auricle (25, Blood Formation) is a trifle larger than the left, its walls being thinner, and its cavity capable of holding about two ounces of blood. The auriculo-ventricular orifice is a large oval aperture, about one inch in diameter, between the auricle and ventricle. The heart contains valves which open when the auricle contracts, and close when the auricle dilates, thus preventing regurgitation.

THE LUNGS.

(See Body plate in Aid.)

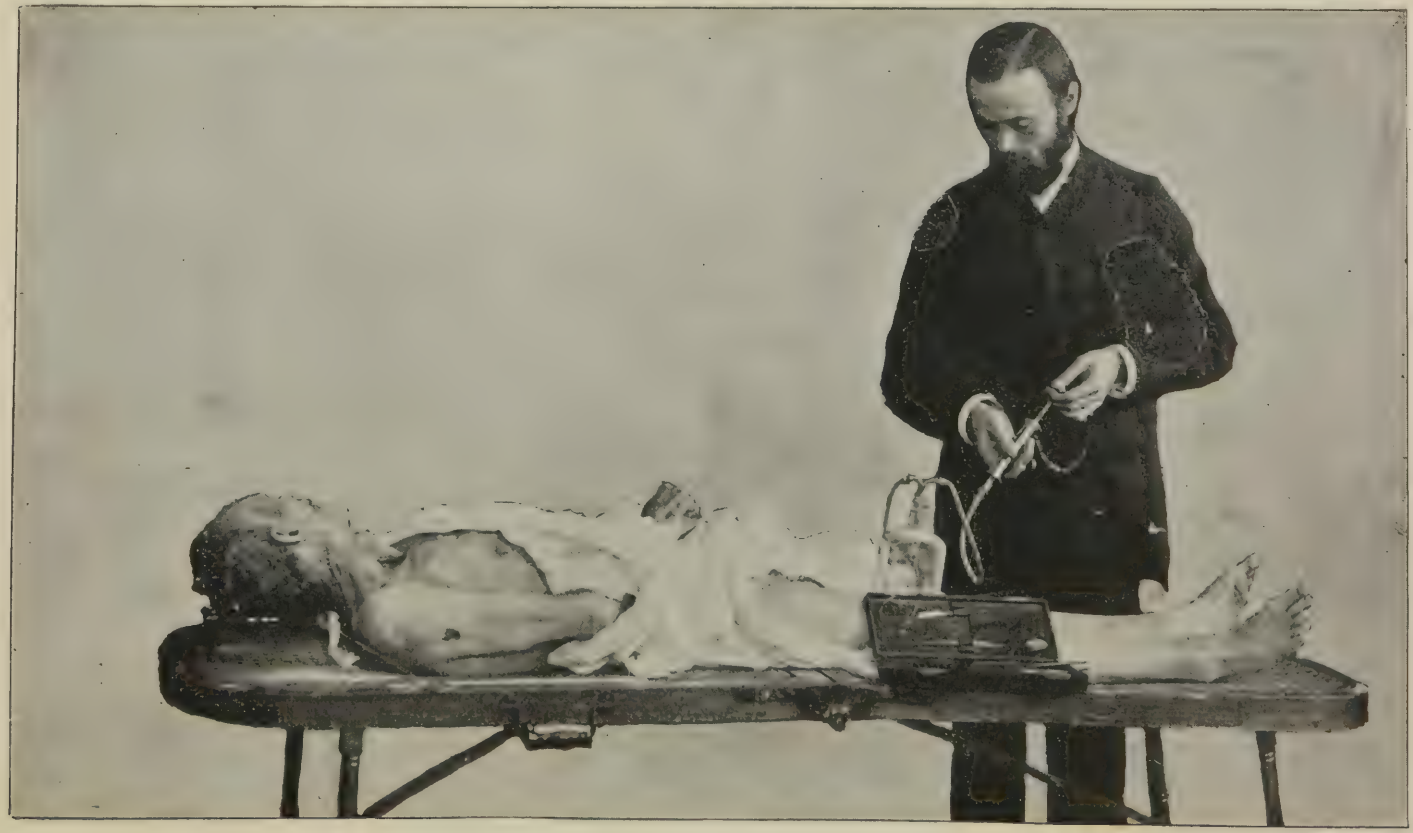
The lungs are two large, spongy masses situated in the cavity of the chest, and extending from the first rib to the

diaphragm. They receive the blood from the pulmonary artery and oxidize or aërate it, sending it purified to the left side of the heart to be distributed to its general circulation. In shape the lungs are conical, and present an apex, a base, two borders and two surfaces. The apex extends into the root of the neck about one inch above the level of the first rib. The base is broad, and rests upon the convex surface of the diaphragm; the posterior border is round and broad, and is received in the deep concavity on either side the spinal column; the interior border is thin and sharp and laps over the front of the pericardium. The two lungs are in contact in the middle line, the pleura only being interposed. Each lung is divided into two lobes. The pleura, which invests each lung on its external surface, is an exceedingly delicate sac-shaped membrane, and incloses the lung as far as its root. The interspace or cavity between the layers is called the cavity of the pleura.

THE STOMACH.

(See plate of Stomach in body of Aid.)

The stomach is the principal organ of digestion. It is placed immediately behind the anterior wall of the abdomen, above the transverse colon (12), below the liver (1-2) and the diaphragm. Its size varies in different individuals, but when moderately full its transverse diameter is usually about twelve inches, its vertical diameter four inches, its weight five ounces. It has two orifices, two extremities, two borders, and two surfaces. Its left extremity, called the greater or splenic end, is the largest part of the stomach, and extends two or three inches to the left of the point of entrance of the œsophagus (1); the pyloric end (4) is much smaller. The œsophageal or cardiac orifice



OPERATOR INJECTING THE FEMORAL ARTERY.

(See page 88.)

(2) communicates with the œsophagus, is the highest part of the stomach, and is somewhat funnel shaped; the pyloric orifice(4) communicates with the duodenum (5), the aperture being guarded by a valve — the pylorus (4). The structure of the stomach consists of four coats. The arteries supplying the stomach are the gastric (7, Blood Formation), the pyloric and right gastro-epiploic branches of the hepatic (8, Blood Formation), the left gastro-epiploic and vasa brevia from the splenic (9, Blood Formation).

THE INTESTINES.

(See Intestine plate in body of Aid.)

The small intestine is that part of the alimentary canal in which the chyme is mixed with the bile, the pancreatic juice and the secretions of the various glands imbedded in the mucous membrane of the intestine, and also where the separation of the chyle, the nutritive principle of the food, is effected. It is a convoluted tube about twenty feet in length, gradually diminishing in size from its commencement to its termination, and contained in the central and lower parts of the abdominal cavity, surrounded above and at its sides by the large intestine. The small intestine is divided into three portions, the *duodenum* (5, Body), the *jejunum* (7), and the *ileum* (7). The duodenum is about ten inches in length, and is the shortest, the widest and the most fixed part of the small intestine. It has no mesentery, and is only partly covered by the peritoneum (A 2); its curve is similar to a horse-shoe in form, the convexity directed to the right, the concavity to the left, and, embracing the head of the pancreas (19, Body), it terminates in the jejunum on the left side of the second lumbar vertebra. The jejunum, so called because it is usually found empty after death, includes the upper two-

fifths of the small intestine. It commences at the duodenum and terminates in the ileum, and, though wider and possessing coats thicker and of a deeper color than those of the ileum, it is very difficult to distinguish the line of demarkation of the two vessels. The ileum (7), so called from its numerous coils or convolutions, includes the remaining three-fifths of the small intestine, and terminates in the right iliac fossa by opening into the inner side of the commencement of the large intestine. The ileum is narrower, its coats thinner, and less vascular than those of the jejunum.

The large intestine commences at the ileum, and terminates at the anus. It is about five feet in length, being one-fifth of the whole extent of the intestinal canal, is largest at its commencement, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anus. It differs from the small intestine in its greater size, its more fixed position, and its sacculated form. Commencing in the right side (the cæcum) (9), it ascends to the under part of the liver, travels across the abdomen through the epigastric and umbilical regions to the left hypochondriac region, descends to the left iliac fossa, where it forms the sigmoid flexure, then descends through the pelvis to the anus, in its course having described an arch surrounding the convolution of the small intestine. The large intestine is divided into three sections or divisions, called the cæcum (9), the colon (14), and the rectum. The cæcum, that part or sac in which the large intestine commences, is two and one quarter inches in length, in breadth three inches. The colon (14) is divided into four parts, the ascending, the descending, the transverse and the sigmoid flexure (last plate Female Genital Organs). The ascending

colon (10) is smaller than the cæcum; the transverse colon (12) is the longest part of the large intestine, and passes transversely across the abdomen from right to left, in its course describing an arch; the descending colon passes almost vertically downward to the left iliac fossa, where it terminates; the sigmoid flexure, the narrowest part of the colon, is situated in the left iliac fossa, commencing where the descending colon terminates, and ending in the rectum; the rectum is the terminal part of the large intestine, and extends from the sigmoid flexure to the anus, and is from six to eight inches in length. The large intestine has four coats, the serous, the muscular, the cellular, and the mucous. Both the large and small intestine are supplied with blood by the superior and inferior mesenteric arteries (11, Blood Formation), as well as from many of the abdominal branches, which are all branches from the aorta (4, Blood Formation).

THE ABDOMEN.

(See Body Section of Aid.)

The abdomen is the largest cavity in the body. It is oval in form, and is bounded in front and at the sides by the lower ribs and the abdominal muscle, behind by the vertebral colnmn, above by the diaphragm, and below by the brim of the pelvis. The abdomen contains the greater part of the alimentary canal, and some of the accessory organs to digestion; viz., the liver, pancreas, and spleen, and the kidneys and supra-renal capsules. For convenience of description, the abdomen is divided into nine separate regions; the right upper region is called the right hypochondriac, the left upper region the left hypochondriac, the upper center region the epigastric, the right center region the right lumbar, the central region the

umbilical, the left central region the left lumbar, the right lower region the right inguinal, the central lower region the hypogastric, and the left lower region the left inguinal.

The right hypochondriac region contains the right lobe of the liver, the gall-bladder, part of the colon, and part of the right kidney. The right lumber region contains the ascending colon, part of the right kidney, and a small portion of the small intestines. The right inguinal region contains the cæcum (9, Stomach plate), the ureter (24, Back plate), and spermatic vessels. The epigastric region contains the middle and pyloric end of the stomach, the left lobe of the liver, the pancreas (19), the duodenum, parts of the kidneys, the supra-renal capsules, the aorta, and branches of the vena cava and thoracic duct. The umbilical region contains the transverse colon, part of the great omentum and mesentery, part of the duodenum (5, Stomach Plate), some portions of the jejunum (7), and ileum (7), also part of both kidneys. The hypogastric region contains the convolutions of the small intestines, the bladder if distended, and the uterus during pregnancy. The left hypochondriac region contains the splenic end of the stomach, the spleen and extremity of the pancreas, the splenic flexure of the colon and part of the left kidney. The left lumber region contains the descending colon, part of the omentum, part of the left kidney and some parts of the small intestines. The left inguinal region contains the sigmoid flexure of the colon, the ureter, and spermatic vessels.

THE LIVER.

(See Body Section of Aid.)

The liver is a glandular organ of very large size, which secretes the bile, and effects changes in the blood in its

passage through the gland. It is situated on the right side, in what is known as the right hypochondriac and epigastric regions, and is the largest gland in the body, weighing from three and one-half to four pounds; its measurements transversely being from ten to twelve inches, six to seven inches in thickness, and about three inches at the back of the right lobe (1), that being the thickest part. Its upper surface is convex, smooth and covered by peritoneum; its under surface concave, directed downward and backward. Five fissures are seen upon the under surface of the liver, named the longitudinal fissure, the fissure of the ductus venoses, the transverse fissure, the fissure for the gall-bladder (3), and the fissure for the inferior vena cava. The longitudinal fissure is a deep groove, which separates the right lobe of the liver from the left; the fissure of the ductus venoses is the back part of the longitudinal fissure, and is shorter and more shallow than the anterior portion; the transverse, or portal fissure, is short but deep, and years ago was supposed to be a gateway of the liver, therefore the large vein which enters at this point was called the portal vein (4); the fissure for the gall-bladder is shallow and oblong, and, placed on the under surface of the right lobe, it extends from the anterior free margin of the liver; the fissure of the interior vena cava (5) is short and deep, almost a complete canal, and extends upward from behind the right extremity of the transverse fissure to the posterior border of the liver, where it joins the fissure for the ductus venoses. The right lobe of the liver is larger than the left, in proportion about six to one, occupies the right side almost exclusively, and is separated from the left lobe on its upper surface by the longitudinal ligament. The left lobe is more flattened than the right, its upper

surface convex, its under surface concave, is situated in the epigastric region, and rests upon the front of the stomach. The vessels connected with the liver, five in number, are the hepatic artery (between 7 and 4), the portal vein (4), the hepatic vein (smaller 5), the hepatic duct (7), and the lymphatic. The substance of the liver is composed of lobules held together by an extremely fine areolar tissue, the lobules forming the chief of the hepatic substance.

THE GALL-BLADDER.

(3. See Plate of Liver in Aid.)

The gall-bladder, the reservoir for the bile, is pear-shaped, and lies on the under surface of the right lobe of the liver. It is about four inches in length, one inch in breadth, and holds about one ounce.

THE PANCREAS.

(See Last Plate of Body in Aid.)

The pancreas (19), which is a compound gland, analogous in its structure to the salivary glands, is situated across the posterior wall of the abdomen. In shape it is transversely oblong and flat, in length about seven inches, one inch and a half in breadth, and about three-quarters of an inch in thickness. Its weight is from three to four ounces. The arteries of the pancreas are derived from the splenic (U) and pancreatico-duodenal branches of the hepatic (8, Blood Formation) and the superior mesenteric; its veins open into the splenic (21, Blood Formation) and superior mesenteric veins (22, Blood Formation).

THE SPLEEN.

(See Last Plate of Body in Aid.)

The spleen (18) is an oblong, flattened form, soft, of very brittle consistence, of a dark-blue color, and situated in the left hypochondriac region. Its external surface is

convex, smooth, and in relation with the under surface of the diaphragm, which separates it from the ninth, tenth, and eleventh ribs on the left side. The internal surface is slightly concave, and, divided by a fissure, is in relation in front with the great end of the stomach, below with the tail of the pancreas. The upper end is thick and round, the lower end is pointed. The spleen is held in position by two folds of peritoneum, one connecting it with the stomach, the other, the suspensory ligament, with the under surface of the diaphragm. Though varying in size, the spleen is usually found to be about five inches in length, from three to four inches in breadth, about one and one-half inches in thickness, its weight being about seven ounces.

THE KIDNEYS.

(Back Plate of Body in Aid.)

The kidneys (20) are situated in the back part of the abdomen, in the loins, one on each side of the vertebral column, resting upon the lower part of the diaphragm, and are surrounded by a large quantity of fat and loose tissue. Sometimes the kidney, becoming loosened from this vast quantity of fat, is only held by the blood-vessels and ureter (24), and it is then called a "floater." The right kidney is usually lower than the left, and is covered in front by the right lobe of the liver, the descending portion of the duodenum, and the ascending colon; the left, a trifle longer than the right, has in front the fundus of the stomach, the tail of the pancreas, and the descending colon. In shape the kidney is convex outside or posteriorly, and concave on its internal border; it also presents a pelvis (22) for examination. Each kidney is about four inches in length, about two and a half inches in

breadth, and a trifle more than one inch in thickness; its weight varies in the adult male from five to six ounces, in the adult female it is about five ounces. The ureters (24), two in number, are tubes which conduct the urine from the kidneys into the bladder. They are from sixteen to eighteen inches in length, and in diameter about the size of an ordinary goose-quill, and extend from the pelvis (22) of the kidney to the bladder. They possess three coats, muscular, mucous and fibrous.

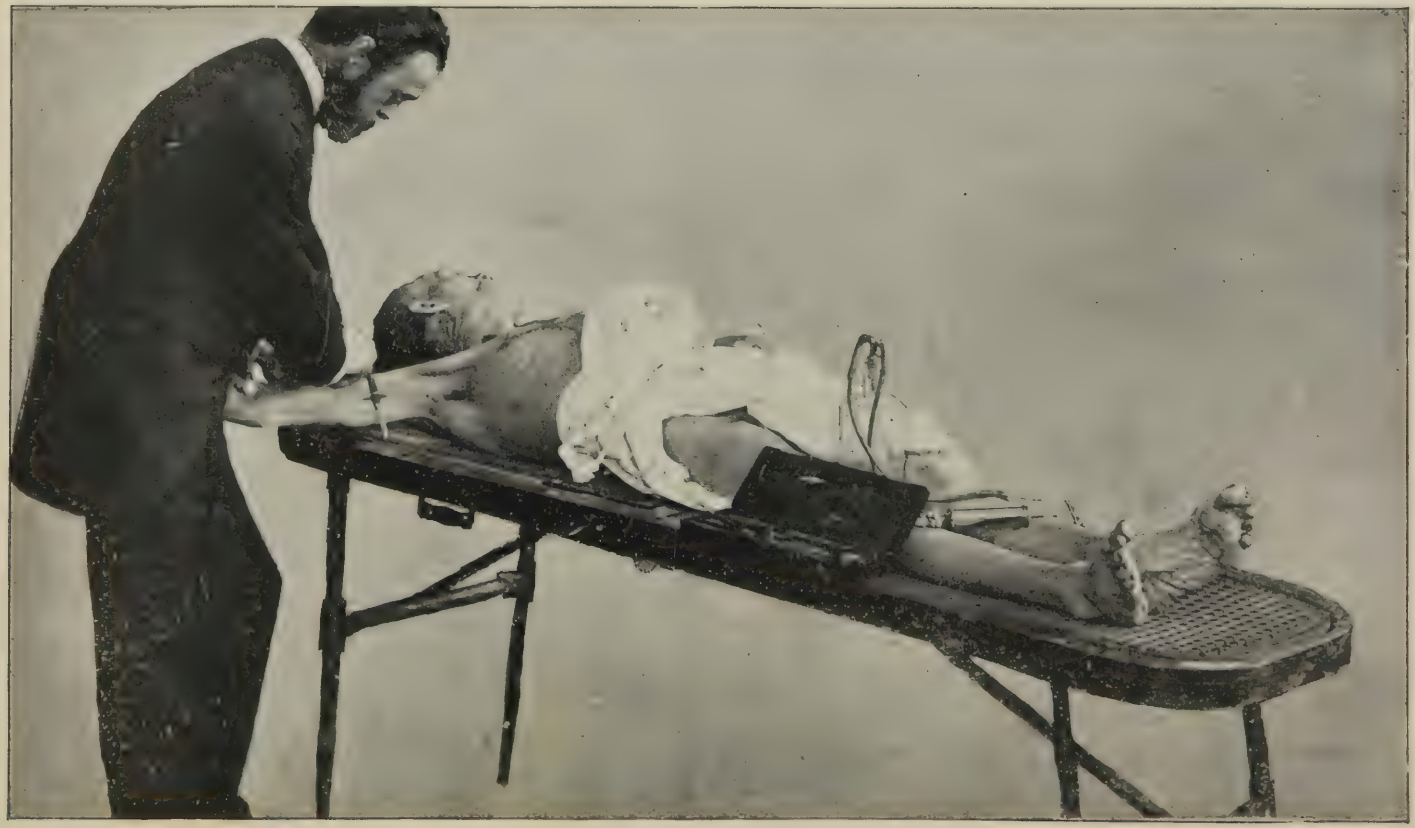
THE BLADDER.

(See Body Section of Aid.)

The bladder is a reservoir which contains the urine. It is a muscular, membranous sac or pouch, in the male situated in the pelvis (22), behind the os pubes and in front of the rectum; in the female, between the rectum, the uterus and the vagina. It is capable of very great distension, but in its usual condition measures about five inches in length, three inches across, and ordinarily it contains about one pint. The structure of the bladder is made up of four coats, a serous, a muscular, a sub-mucous and a mucous coat. The arteries supplying the bladder are the superior, middle, and inferior vesical in the male, the female having additional branches from the uterus and vagina. The male urethra extends from the neck of the bladder to the meatus urinarius, its length varying from eight to nine inches, its caliber about three-eighths of an inch. It is composed of one continuous mucous membrane, and is supplied with blood from the branches of the inferior vesical, the internal iliac, and the dorsal artery.

THE DIAPHRAGM.

The diaphragm is a thin, muscular, fibrous septum, separating the thorax from the abdomen, forming the floor



OPERATOR RAISING THE BRACHIAL ARTERY.

(See page 85.)

of the thoracic cavity and the roof of the abdominal cavity. It is nearly fan-shaped, has three large openings and several smaller openings, the former for the passage of the aorta, the œsophagus and the vena cava. It is arched, being convex toward the chest and concave to the abdomen, and is supplied with blood by the phrenic artery. The diaphragm is constantly called into action, as it is the principal muscle of respiration.

HINTS AND SUGGESTIONS.

We wish to call your attention to the practical application of the Embalmers' Anatomical Aid to your daily business. The Aid is not only a valuable appliance for reference and demonstration on the part of the funeral director, but enables him at all times to see exactly what he is doing. We take pleasure in calling your attention to the skin plate lying directly over the muscles in the body section of the Aid. This being made transparent, and arranged so as to place over any or all of the vital organs of the body, affords many advantages, as it enables you to see their true relation to the skin surface, which is quite important when introducing the needle or trochar. The organs as represented in the Aid correspond with the size of this body; so, to find any particular spot on the body on which you are operating, simply take the length and breadth of the trunk (or body) and allow for the difference in size. You can thus locate exactly the organ or spot required, and avoid penetrating arteries.

The skin plate is also valuable in showing the course of the trochar or needle, and just what arteries and veins, if any, are punctured. For instance (for cavity embalming), take for the point of injection about two inches above the umbilicus (navel), draw a line with lead pencil on the skin plate in the direct course you wish the needle to go (of course allowing for difference in size of bodies), raise up the skin plate, remove the muscles, and dropping skin plate over each organ, will show exactly the course taken by the needle.

Notice the manner in which the Aid is put up. You see it is folded in a thin portfolio, and covered with a strong canvas case which enables it to be kept, if desirable, in the embalming board or table.

PRELIMINARY HINTS.

The object of embalming the dead is obvious. It is the only means of keeping the body for an indefinite time, and of knowing that it will retain its life-likeness. It further prevents all obnoxious odors and gases from arising, rendering the body wholesome and beautiful in the eyes of relatives and friends. And, as the embalming liquids contain antiseptic properties, a great health-preserving service is at the same time rendered the public. The competent embalmer benefits himself by his knowledge. Embalming seems to the ordinary mind a mysterious application of a difficult science. A thoroughly skilled embalmer, with his intimate knowledge of the human body, properly steps into a higher place than the ordinary undertaker. You enter the house of the dead like a physician with your little cabinet of instruments, and proceed to do your beneficent work. On arrival, after a few words of general conversation, you should ask to be shown the room in which the body is lying, and at once proceed with your assistant to make examination. In a few brief questions ascertain the cause of death, how long the dead was sick, in what room the body is to remain until the funeral. Quietly request some water, either warm or cold, remembering that at such a time little duties and cares become a relief to the friends. Further, it begets a confidence in your abilities, for human nature dearly loves to be consulted at all times. A little later, ask for soap, a towel, an old sheet to be torn up and made use of in various ways.

Should any of the friends have a desire to remain in the room, which is not likely, do not offer objections, as this would tend to awaken suspicion. Always permit it, and especially if the body be that of a child or a female. You cannot gain the people's confidence in any easier or gentler way. The chances are it will be a help to you, as, after they have asked your permission to remain, they could hardly refuse to render you assistance if needed. First remove the body from the bed to your embalming table or cooling board, never for an instant forgetting that you are in the chamber of death. Allow no unnecessary conversation. Your work should go on as quietly as possible. Proceed with all the haste you can command, consistent with care and thoroughness, for the friends will be anxiously awaiting developments. Answer questions as to the length of time during which the body can be kept, as indefinitely as possible, as there is always a possibility of mistake. But if your work be well done there should be no difficulty in satisfying the most exacting.

SUGGESTIONS AND CAUTIONS IN THE SELECTION OF ARTERIES FOR INJECTION.

Never work too hurriedly, and always watch the subject, for in some cases damage may occur by rupturing an artery. Although this happens rarely, as the arteries are very tough and elastic, yet it is extremely advisable never to force the pump too fast. Give it gradual and steady motion, and no difficulty will be experienced. At least one and a half to two hours should be devoted to embalming a body, the time given depending upon its condition, size, weight, how long dead, and the length of time to elapse before interment. Too much fluid can be used, as

well as too little. Your own good judgment must come in at this point, as each case shows variation. Another point of importance is to carefully watch the body for the first twenty-four hours, and, if there should be a change, immediately find the cause and make repairs at once. After the first twenty-four hours, if everything is in good order, you need have no further apprehension.

The Posterior Tibial Artery is of considerable size, and is not very difficult to find. Make an incision about three inches in length along the lower third of the leg in a direct line. This incision must be very carefully made, as the artery lies in a very superficial position about two inches above the internal ankle joint and about a half-inch below it. Direct down with the handle of the scalpel, or knife, and, as a rule, it is easily and rapidly brought to view. It is sufficiently large for embalming purposes, and can frequently be used. Indeed, it is the handiest and most superficial artery we have for embalming purposes, and is now being used by many embalmers with great satisfaction. One advantage it possesses is that the operator can have perfect control of the part without the aid of an assistant, as he will have nothing to hold during the operation but the knife and aneurism needle or embalming hook. No obstruction will be found, except, perhaps, a clot of blood which may have settled in the artery, but that will soon be distributed, as the embalming fluid will break it up. The circulation in this artery is most complete, as the fluid readily ascends into all its branches, and regurgitates to the foot. At the same time that the fluid is ascending through the body through the femoral artery and common iliac, the recurrent branches are catching it up and distributing it to the muscles and tissues of the leg, thus completing the embalming of that member. By the time the body has been thoroughly in-

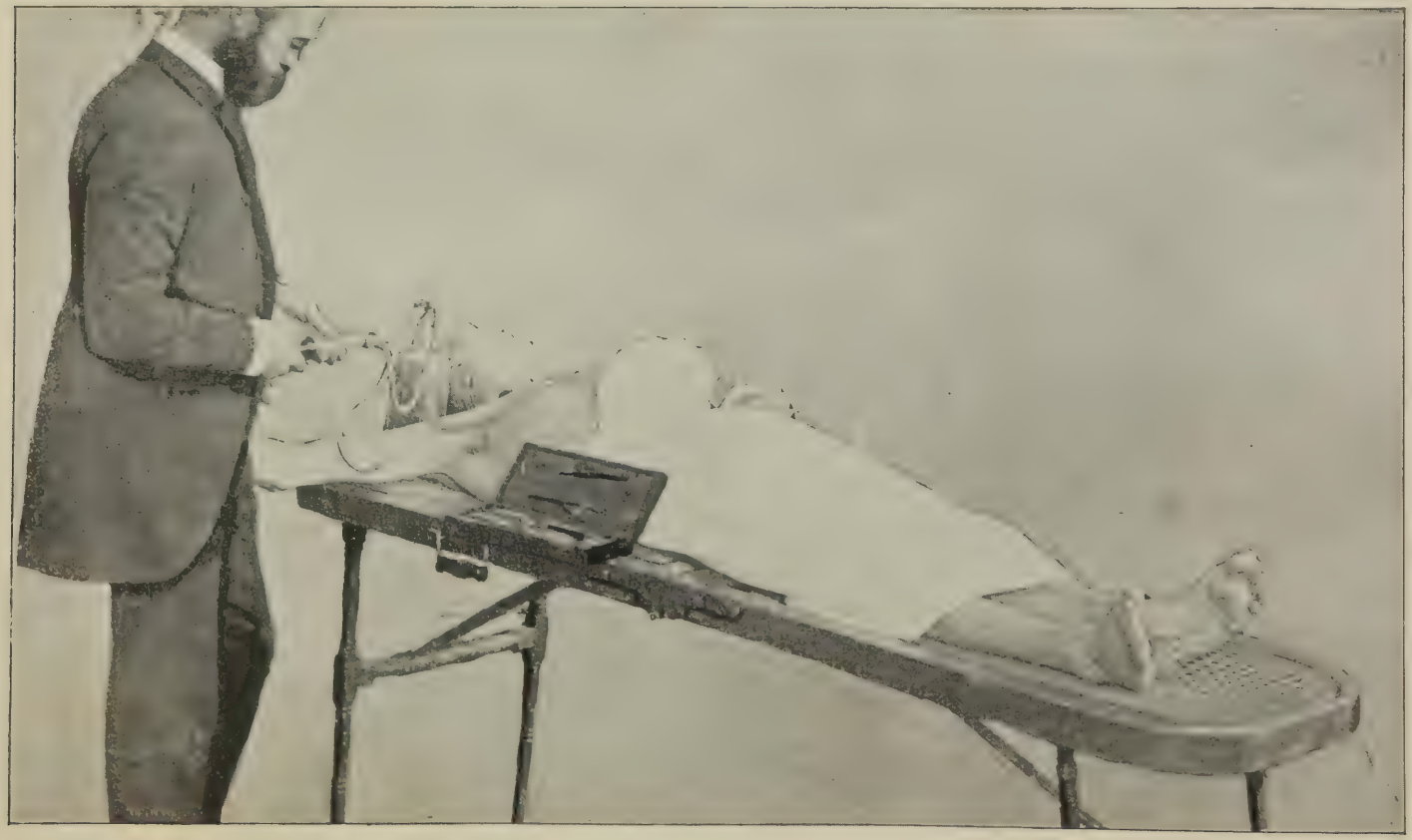
jected, the course of the flood or circulation is constantly ascending and descending through the arteries and their branches, the aorta taking the fluid from the common iliac arteries and sending it in and about all its numerous branches through the abdominal cavity, into all the viscera and blood-vessels, to the integuments, and, in fact, to the most remote part of the body. The aorta carries the flood into the thoracic aorta, and then distributes it to the heart and lungs, through the coronary and the pulmonary arteries and veins, which give off many branches to all the parts contained in the cavity of the thorax; it then ascends into the arch of the aorta, follows to the innominate arteries, and there distributes the flood to the subclavians, which supply the upper extremities of the body, passing at the same time into the common carotids, the vertebrals, the mammary branches, the circumflex, the posterior and anterior arteries, the axilla, and then into the brachial, following its course to the radial, ulnar and interosseous arteries, giving off, as they are filled with the fluid, very many branches to all sections of the arms, thus supplying the muscles and fascia with fluid after death, in the same way that they are supplied with blood during life. The hands and fingers take their supply from the termination of the radial and ulnar arteries into the palmar arch, that supplying the digital branches to the ends of the fingers, in the same way as the plantar arch (N, lower part plate 5, Lower Extremity) supplies the foot through the dorsalis pedis, dorsalis hallucis, and digital branches to the toes. At the time the fluid enters the subclavian artery from the arteria innominata, to pursue its course to the arm, it enters the head by the common carotids and vertebral arteries, and is thus distributed to the facial arteries, the temporals, the maxillaries, the

frontals, the basilar, the cerebrals, and all their branches. The head and face receive their supply at a very moderate pressure, the force being largely spent, thus avoiding the danger of blackening or discoloring the face.

To professional embalmers one of the most important arteries is the Right Common Carotid (1, Blood Formation). Its advantages are that it is large enough to admit almost any size tube; it is very easily found or located; it receives the fluid injected rapidly, as it passes directly into the large arteries, joining the recurrent branches, which are very small. This allows the gradual embalming of the head and face, the main or large trunks carrying the fluid, and distributing it quickly to the lower and upper extremities at the same time, thus acting from the common carotid artery as from the posterior tibial, only completing its circulation more rapidly. This saving of time is in some instances a very important point. The Femoral Artery is very large, and can be used in children as well as in the adult; a large-sized tubing can be introduced into its canal in the latter case, and a smaller size in the child. On account of its location in the thigh, and because, as a rule, the body is dressed, this artery is not frequently used. Yet, in most cases, it is a good artery to inject, and at certain times, which will be mentioned in the chapters on embalming, it should be used, notwithstanding objections.

The last but not the least important artery for embalming purposes is the Brachial Artery, situated in the arm, of good size, and capable of receiving a large-sized tube in its canal. This artery is universally used in many cases of embalming with the best success, its location admitting of its use at any time in female as well as in male subjects. It is easy to find on account of its landmarks, the borders of the biceps and triceps muscles ; it is more superficial than any

of the others that are used, excepting, perhaps, the posterior tibial artery, and it receives the fluid easily and readily. The arm being directed outward in a horizontal direction gives the course of the brachial almost straight to the arch of the aorta, through the axillary and subclavian arteries, the vertebral and common carotid receiving the fluid on its course, and carrying it to the face, head and brain, passing around the circle of Willis, and supplying the numerous branches which are given off in their locations, thus embalming the upper and lower extremities at one and the same time. It is evident that embalming through the brachial artery has great advantages, yet we run a larger risk of discoloring the face with this artery than with any other, on account of the head and face being so near the first force of the current of fluid. A clot of blood may be distributed to the face by way of the facial arteries more readily on account of the common carotid artery being in a direct course and receiving the fluid from the artery in its course through the aorta. Yet if the pump is used slowly, this seldom happens and the discolorations are easily removed. The superior and inferior profunda of the brachial carry the fluid to the lower extremities, thus distributing it through the entire system. Especial care should be exercised in embalming the abdomen, and it is essential to have thoroughly in mind the nine regions into which it is divided, and the contents and capacity of each. In the right hypochondriac region very little fluid can be injected, as the liver occupies nearly all of its space. Though the contents of the umbilical region are many, a large quantity of fluid may be used because of its large size and position. The right lumbar, right inguinal, hypogastric and left inguinal regions are all capable of taking a good quantity of the fluid, while the epigastric, the left



OPERATOR INJECTING THE BRACHIAL ARTERY.

(See page 86.)

hypochondriac, and the left lumbar regions are much more limited in capacity. Careful study of these tracts in their relation to each other will be assisted by marking them with chalk on the abdomen of the dead subject.

HOW TO LOCATE, RAISE, AND INJECT THE BRACHIAL ARTERY.

(Illustrated, pages 60 and 68.)

We now pass on to the brachial artery, which is one of the smaller arteries, yet can be substituted for either one of the others and used to great advantage by most embalmers, on account of its position (being easy to locate and handle), in four-fifths of the adult cases, but seldom in the case of children, on account of its small size.

The Brachial Artery (B, plate 4, Upper Extremity) is the continuation of the Axillary Artery, and commences at the entrance into the arm from the axilla, or arm-pit. It continues, in a more or less spiral course, to the bend of the elbow, where it gives off two branches, which are called the radial and ulnar arteries. If the arm is directed outward in a straight line from the body, with the palmar surface of the hand upward, the artery pursues an almost straight course. For this reason it is advisable to extend the arm outward before making an incision, then you can make your cut in a straight course, and with exactness. The artery lies near the Humerus (the bone of the arm), and between the two great muscles, the biceps and triceps, the biceps being on the upper side, and the triceps on the lower side, of the artery. It lies along their edges or interior borders, and is hidden from view until the muscles are separated. That work is accomplished easily by the use of the handle of one of your instruments, but the fingers are the better instru-

ments for this purpose, as you can in this manner feel your way. Make the incision about two or three inches below the arm-pit and in the middle of the arm between the muscles. Make it from two to three inches in length. Cut through the skin and fascia on a straight line with the bone of the arm.

Then separate very carefully the fat and muscles, and hold the muscles apart, thus exposing to view a number of vessels, cords, nerves, etc. You are seeking the artery, and must make your selection by the sense of touch, by its pink or bright color, and from the fact that it is *distended* to a certain extent. When found, separate it from its fellows, which in some cases adhere to it, making the operation an awkward and stubborn one. They are, as a rule, however, easily and readily separated from each other. The artery should be raised to the surface, and two strings passed under it. Then raise the vein, and proceed in the same way as for the artery. You can open this vein in the arm to relieve the discolorations in the face, if necessary. This sometimes acts very nicely, and performs its work as well as the Jugular, but ordinarily, where there is discoloration in the face, it is advisable to use the Carotid Artery and the Jugular Vein. But always remember to insert the nozzle of your instrument into the artery before opening the vein—the work will thus be better done. After bringing the artery to the surface, and after the strings are placed, tap it by inserting the point of your scalpel into it, the artery being stretched across the handle of an instrument or over your fingers. Then insert the nozzle into the opening you have made, pointing it toward the head, then make the nozzle fast by ligatures already prepared, and start your pump, using the greatest care in this case, as you are forcing the fluid direct to the branches

that carry it to the face and head. Great care should always be observed in using the brachial artery on this account, as you might, by quick or rough work, force the blood into the face, thus causing discoloration. You need not do this, however, if due care is used. Injection can be very readily made into the brachial artery, and it is advisable to use it whenever the conditions are right, as the fluid gets a complete circulation, and you can cover up your work more easily in this than in either of the other arteries used, which is a valuable point to be gained. When you have completed the injection according to your own judgment, tie a ligature in front of the nozzle and withdraw it, after cutting it loose. This tying of a ligature in front of the artery is a good point, and should be impressed upon the mind of the operator. After withdrawing the nozzle, sew up, and stop all leakage.

HOW TO LOCATE, RAISE AND INJECT THE FEMORAL ARTERY.

(Illustrated, pages 76 and 84.)

The next artery of importance, on account of its size and the frequency of its use in different causes of death, is the Femoral.

The Profunda is a branch lying directly alongside of it, and is often used in place of it. There is but little difference between them, and one is used as often as the other. Use either, just as you happen to strike it.

The Femoral Artery is the continuation of the external iliac artery (F, back plate Body), and enters the thigh from its continuation after passing over the crest of the ilium (39, back plate Body) and under Poupart's ligament (31, Muscle Plate). Immediately upon its entrance into the thigh it becomes the Femoral Artery. It pursues a

spiral course, and continues down to the lower third of the thigh, when it becomes the popliteal artery (H, plate 5, Lower Extremity).

About one and one-half inches below Poupart's ligament, it gives off a branch as large as itself, which supplies the lower tissues and circulations with its many branches.

The Femoral Artery can be located about the middle of the thigh and between its great muscles, about two inches below Poupart's ligament. In making your incision, therefore, you mark out your course from about two inches below the center of Poupart's ligament, near the middle of the thigh, and dissect perhaps an inch or an inch and a half down through the soft tissues that you come in contact with. Divide and cut until you come to the large muscles of the thigh, then separate and place them on either side, after which you will discover the Femoral and Profunda lying side by side and accompanied by the Femoral Vein, the venæ comites, two in number, and the great nerves of the lower extremities. Your greatest difficulty will lie in separating these one from another, but care will accomplish it. After separating the Femoral from the Profunda, if you have struck it accurately, you can raise either one to the surface and pass your ligatures around it, as explained in the case of the Common Carotid Artery, one on each end, and allow them to hang loose until you need them. If it seems wise to tap the vein in this instance, it can be done provided the nozzle is first inserted in the canal of the artery. Otherwise, the blood flowing from the vein will obliterate your work to some extent. But, the nozzle being in position, then, if you see fit, make the incision, first, however, having raised the vein to the surface. Attach the pump to the nozzle that is placed in the canal of the artery, and pump slowly at first, but with a quicker motion as you proceed,

though never hurriedly. After the fluid runs out of the vein, tie it up and make it fast, place it in its position, and watch the back end of the artery you are injecting. Keep a sharp lookout for any leakage, and also examine the upper part or extremity of the body, and see if your fluid has found its way into the temporals and facial arteries, and if they are bulged at all. If you find they are, stop at once. Never work rapidly. Be moderate and careful. As soon as any leakage presents itself, tie up the back end of the artery and complete your work. You will have now but one thing to look to, and that is the body. Keep your wits about you. Do not trust too much to your assistant unless he is practically versed in the profession and trustworthy. When, according to your own judgment, you have injected the required amount, tie or ligate the artery in front of the nozzle ; tie it firmly, and cut the thread that holds the nozzle, and withdraw it. Look out for leakage. If any appears, gather up the surroundings, and pass a ligature through and around the whole mass, using your aneurism needle in these cases, as it is much more convenient and decidedly easier to handle. All leakage being stopped, sew up the wound as already explained in case of the Carotid Artery, and cover with flesh-colored court plaster. It is not advisable to use the Femoral Artery in all cases, as in females, for instance, on account of its location; yet it should be used when necessary.

HOW TO LOCATE, RAISE AND INJECT THE POSTERIOR TIBIAL ARTERY.

The Posterior Tibial Artery is very seldom used, yet it will rank among the first in the future by reason of its location and its being superficial and very easy to locate and raise. This artery (lower part of plate 5, Lower Ext.)

is a continuation of the popliteal (plate 5, Upper Ext.) and descends on the inside of the tibia bone. At its beginning it is quite deeply seated, but becomes superficial as it descends toward the internal ankle. It then passes into the foot and travels its internal edge, crosses over under the sole of the foot, and communicates with the plantar artery and the internal tibial artery. At the point of incision, the posterior, while superficial, is quite small, and yet is frequently as large as the brachial in the arm. The incision must be made about two inches above the internal ankle, and about one inch below it in a direct line. The point of incision should be midway between the internal ankle, and the tendon of Achilles (No. 19, plate showing points of injection), which is the large tendon running up from the back part of the heel to the large muscle at the back of the leg. The location is plain, and the injection easy. The artery is readily reached by dissecting down. It is available for use in most cases. This artery is treated just as are the others. Point the nozzle upward toward the body, injecting very slowly at first.

At the completion proceed as ordinarily. Never use this artery in severe cases. In cases of consumption or of old age, and more especially in emaciated cases, it can be used with entire satisfaction. The artery in the right leg is generally used.

HOW TO LOCATE, RAISE AND INJECT THE RIGHT COMMON CAROTID ARTERY.

(1, Blood Formation, and 19, Head plate.)

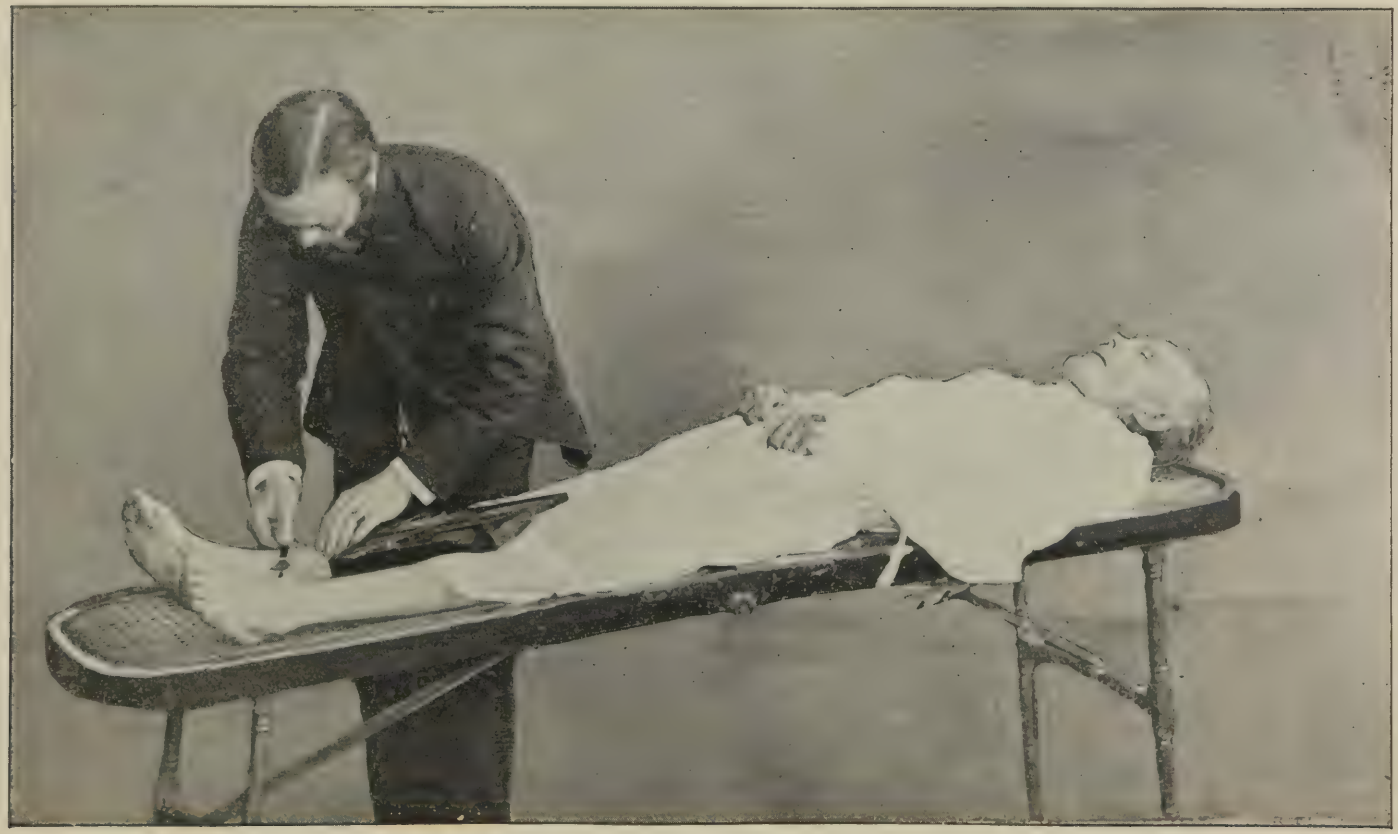
First as to its location. It is a branch of the arteria innominata (2, Blood Formation), and arises from behind the right sterno-clavicular articulation, and proceeds in a direct line to the upper border of the thyroid cartilage,

when it divides into the external and internal carotids. The direct course, then, of the Right Common Carotid Artery is from the sternal end of the clavicle (5, Rib Plate) to the mastoid process, a point indicated by the lower lobe of the ear.

To raise it for embalming purposes, mark out a line as indicated, and choose for the point of incision its lowest part, as near the clavicle (collar bone) as possible. Then make an incision directly on a line with the clavicle, commencing at the sterno-clavicular articulation (the head of breast bone), and extending along the edge of the clavicle for the distance of about two and one-half or three inches. Then make another incision at right angles with the former one, about one and a half to two inches in length, extending in a direct line with the lower lobe of the ear. Care should be taken, however, in making these two incisions, that they be made no deeper than the skin.

The incisions should resemble a large letter L; thus, L. When completed, proceed to dissect the skin very carefully from the fascia which is fastened to it, for the whole distance of your incision. After dissecting the fat from the skin, turn the flap of skin over, care being taken to see that no holes have been made in the skin during its separation from the fat. Then dissect down through the fasciæ, being constantly careful all this time not to rupture any of the vessels you may come in contact with, for you must remember that you are now working near or next to the windpipe and the sterno-cleido mastoid muscle, and you are separating the tissues between these important parts in order to expose the arteries and the veins which lie directly beneath. These you will discover on pressing the opening apart with the handle of your instrument or your fingers. Lying in its position open

to your view will be found the Common Carotid Artery — the one you are looking for — with its accompanying veins. Next separate the artery from its adhesion to the vein, using great care in the process. Select the artery and raise it to the surface, guarding carefully against injuring it in any manner. After you have raised it to the surface, be sure of your selection, feeling of it thoroughly, as that is the best method of testing its identity. When positive that you have the coveted artery, pass two pieces of silk or string under it as it lies in position for making your incision with an instrument handle placed under it, one piece at the lower, the other at the upper end, leaving them in that united position for the time being. Then again enter the cavity out of which you have brought the artery, and proceed to locate the vein which you have left behind. When found, bring the vein to the surface, using the same means as you did for the artery, exercising great care in the operation. Pass two pieces of silk or string under the vein, as in the case of the artery. A ligature needle is good for this purpose, threading it with silk or string, and passing it under artery or vein. The needle is handier, and more deft than the fingers, and more scientific. In fact, it is best to use the ligature needle for all purposes of ligating. After you have raised the vein to the surface and passed the ligatures or threads under it, let it rest and proceed again with the artery. Make each end of each ligature into one loose knot, and allow the ends to hang down over the skin of the neck. Make an incision into the artery about its middle, sufficient in size for the insertion of your tube or nozzle. This puncture or incision is to be made for this one purpose, *i. e.*, the introduction of the nozzle in question, and should be made with special reference to its size. The easiest, quickest, and surest way of



OPERATOR RAISING THE POSTERIOR TIBIAL ARTERY.

(See page 89.)

making this incision is to raise the artery over the index finger of one hand, using the point of the scapel with the other, although some danger attaches to this method. Nevertheless, it is preferable to the use of an instrument handle; the latter is, however, a fair substitute for the finger, the only trouble being that you cannot be positive that you have cut through the three coats into the canal until perhaps you have cut directly through the whole artery, thus severing it in twain. Such an accident makes bad work, as the elasticity of the artery carries the severed ends out of sight at once, and you are forced to seek them with much painstaking — the one part far up in the neck, and the other part in an opposite direction.

Too much care cannot be used in this simple little operation of the incision. The finger process is, all things considered, the most advisable. Be sure the incision penetrates the canal of the artery, as it happens occasionally that the cut only reaches through the first or second coat or tunic. In such a case there is trouble again, for the operator is no better off with the first or second coat penetrated than as if no incision had been made. Another test which I invariably use is by means of the stiletto, an instrument made of wire and having a blunt end. This instrument is used as a protection against the sharp point of the embalming needle, and should always accompany it, and always on the inside of the needle. It is about six inches in length. Place the stiletto in the canal, and allow it to enter as far as possible. Usually, on withdrawing it, a few drops of blood will follow, thus affording a sure, easy test. After you are positive you have made a true incision, introduce your tubing into the artery, then tie your silk or string around it, drawing it tight and making it perfectly secure. Make two double knots to be entirely

sure that the tubing is secure in its position. If blood begins to flow, let it flow. It is all the better, as it is a proof of your success.

When the tube is properly in the canal, securely fastened and all in readiness for your injection, tap the vein in the same way as you tapped the artery, and about in the middle, the object of this being to allow the flow of blood from the upper parts or from whatever source it will come. After allowing the blood to escape from the vein for a few moments, should it not flow as fast as you think it ought, assist it by passing your hand over the face and forcing it downward, rubbing each side carefully. Frequently, when there is any discoloration, you will remove it at once in this way and very satisfactorily. It is a method long used, and is very effectual, as by removing the blood, which is the cause, you strike at the root of the trouble. When the blood has ceased entirely, or to such an extent as to permit, begin your injection by attaching the pump to the nozzle already introduced into the canal of the artery. You will notice, after a few motions of the plunger or piston, that the blood will commence to flow again from the vein. Allow it to flow until you see, that, instead of blood, you are getting fluid, which may be detected by the change in color. Then stop injecting, and ligate or tie up the vein at both ends, using the ligatures or strings you have already placed there for that purpose. Be sure to tie them securely so that the fluid cannot leak out. You will not stop the circulation by doing this, as the branches take it up and distribute it just the same as though your ligature was not there. Sink the ends of these ligatures into the cavity, or cut them off out of your way, so that they may not become entangled with the strings you have placed on the arteries,

and proceed with your injection as before. You now have need only of good judgment. Inject carefully and very slowly for a few minutes, and then allow your pump to rest on the body or some convenient place while you make careful examination. Look closely at the superficial arteries, such as the temporal and facial arteries. You will frequently see them raise out or bulge under the strain; but do not mind that, as they will all sink to their natural positions again very shortly. After a few moments, perhaps five, go on with your injection until you have filled in about two or three quarts. There is no rule laid down for the exact amount, yet three quarts will be ample in the average case; still, I have injected, and have seen others inject, a much larger quantity; but ordinarily, where but a few days' preservation only is desired, the above amount will be sufficient. Still, the operator's judgment must be the arbiter throughout. When the injection is complete, tie up the back part of the artery (if not compelled to do it before on account of fluid flowing out). The rule is to tie as soon as the fluid flows out; but sometimes it does not flow; then the ligatures are left untied until the injection is complete. Usually the fluid will ooze out of the opposite end of the artery, and run quite fast from it, if the body has received a sufficient amount of the fluid to reach the entire circulation, thus proving your work. Still, this cannot be relied on in all cases. Tie firmly, cut off the ends of the ligature, then proceed to the opposite end where the nozzle is. Meanwhile, take a short recess; then, if by examination you find that the arteries that were bulged in the temples and about the face have receded, try to inject a small quantity more of the fluid; but if, after the pump has been in hand a few minutes, these arteries bulge again, stop at

once. Then tie up the nozzle end of the artery, thus completing the ligatures. The mode of procedure in tying up the last or nozzle end, is to draw out the nozzle to the point where the first ligature was securely made, then pass a string in front of the small end, and directly around the artery and tie it very securely with two or three knots. Then take the point of the knife or scalpel, and cut the string that holds the nozzle in its position. As soon as it is cut away, the nozzle will come out easily, and your work will be done. You must, however, now look for leakages; these may have come from some little cut inadvertently made with your knife. If any be found, gather it up with the tissues around it and tie in like manner. Next, wipe out with a sponge, and watch for any further leakage, then place a small wad of cotton in the cavity on top of the artery, and vein, which you will have allowed to fall back into position. After packing in snugly sew up the wound with close stitches over and under (as a baseball cover is sewn), and draw each stitch tight. Silk should be used for this purpose. Next proceed to the cavities, which are very important, and of course must be looked after with as much concern as the arterial system. For there will be many cavities into which the fluid has not entered, as it is absorbed in the arteries, veins, muscles, tissues and fat of the body. Therefore follows what is termed cavity work, which will be fully explained in its proper place.

HOW TO LOCATE, RAISE, AND INJECT THE RADIAL ARTERY.

The Radial Artery is very seldom used, on account of the difficulty in obliterating the traces of incision. Other points are far superior to it in this respect, so that it has lost nearly all of the popularity it once had. This artery

(B, plate 4, Upper Extremity) is a branch of the brachial (A, plate 4, Upper Extremity), and begins its course at about the elbow joint, and extends along the forearm to the wrist, where it runs into the hand and anastomoses with its arteries. It is by this artery that physicians feel the pulse at the wrist. By means of its being very near the surface at this point, its course can be readily located and traced. For the purpose of embalming, it can be raised just at the beginning of the wrist and at the end of the ball of the thumb. It can be easily located in the hand or wrist by holding the hand with the palmar surface upward, and feeling along the wrist on a line with the thumb. You can frequently see its pulsations. Having located its track, make your incision through the skin, and separate the fascia with a dull or blunt instrument. However, your fingers are best, as with them no injury will be done to the vessels with which you will come in contact. Select the artery, and raise it to the surface, also the vein, which treat in the same manner as in the case of the other arteries. Ligate the vein if you are going to tap it; if not, do not raise the vein out of its bed, as the artery will suffice for your work. Raise the artery, pass your ligatures under it, leave them hanging loose, tap it with the point of your scalpel, and introduce your nozzle into the canal. Ligate the nozzle, and be sure the ligation is firm, as the Radial Artery is small, and will not bear the passage of much fluid through it at one time. For this reason there will be a strain on the pump and nozzle all the time you are at work. Still, with care, a body can be embalmed through the Radial Artery just as surely as through the larger arteries. After your injection has been completed, proceed in the same manner as with other arteries, except that more care and

attention must be paid to the closing of the wound at the wrist, as it is important to hide all evidences of your work. The neatest and best way is by means of a very fine needle with fine sewing silk to sew up the wound, using great care, taking very small stitches, and drawing the lips of the wound firmly together. Never allow them to overlap each other. When your sutures are finished, place a very small piece of flesh-colored court plaster over them, and sprinkle flesh powder over the whole surface, making the part look as much like the rest of the arm as possible.

HOW TO INJECT FLUID INTO THE STOMACH AND INTESTINES WHEN NASAL PASSAGES AND MOUTH ARE CLOSED.

Raise the body to nearly a perpendicular position, draw the skin under the chin very tightly, make your incision (a little downward) directly above the top of the breast bone, at the point indicated on the Head plate by No. 24, and you will have a clear, direct and unobstructed passage through the œsophagus to the stomach and intestines.

DIRECTIONS FOR REMOVING DISCOLORATIONS FROM THE FACE, EARS, AND EYES.

If the face is discolored and your mode of opening the vein at the artery does not succeed, raise the arm to an upright position and direct your sharp-pointed needle into and through the axilla (or arm-pit). Direct the point well up so as to penetrate the large jugular vein, that is situated in the neck; penetrate it slowly, guiding the needle with the fingers of the left hand, and enter at a point in the neck about three inches above the clavicle (collar bone). You

can in this way drain the discoloration from the face without trouble, as the bood remains fluid, and will enter and flow through the duct thus made. Use your hands to facilitate the movement; *i.e.*, pass your palms over the face very gently, yet firmly enough to force the blood to the vein and out into the needle, and thence into a vessel prepared for its reception. The discolorations generally yield to this treatment, so that you may successfully remove them all. Usually the eyes, the spaces under them, and the ears yield at the same time. If they do not, and if there should be any spots left on the face, they would be near or at the sides of the nose. In such case, use a hypodermic syringe, passing it up the nostrils on the inside, and penetrate the outside tissues; or, you can pass the needle directly under the skin and remove the blood that is settled there, and then force a very small quantity of fluid through the needle into the opening, which will bulge out the surface, but can be smoothed down by passing the fingers gently over the part, thus spreading the fluid to a large area and removing all discolorations at once. If, however, the discolorations still remain, remove your needle and force the fluid out with your fingers by rubbing them toward the point where the needle entered, and then introduce more fluid. Repeat the operation in the ears and eyes, passing the needle behind the ear, and enter the point where the discoloration exists. You will find this method effectual. In treating the eyes, use the lower lids; pull them down, and pass your needle on the inside and to the point of discoloration. This treatment may be applied with equal success to any part of the body.

USE OF HOT, DRY WOOLEN CLOTHS.

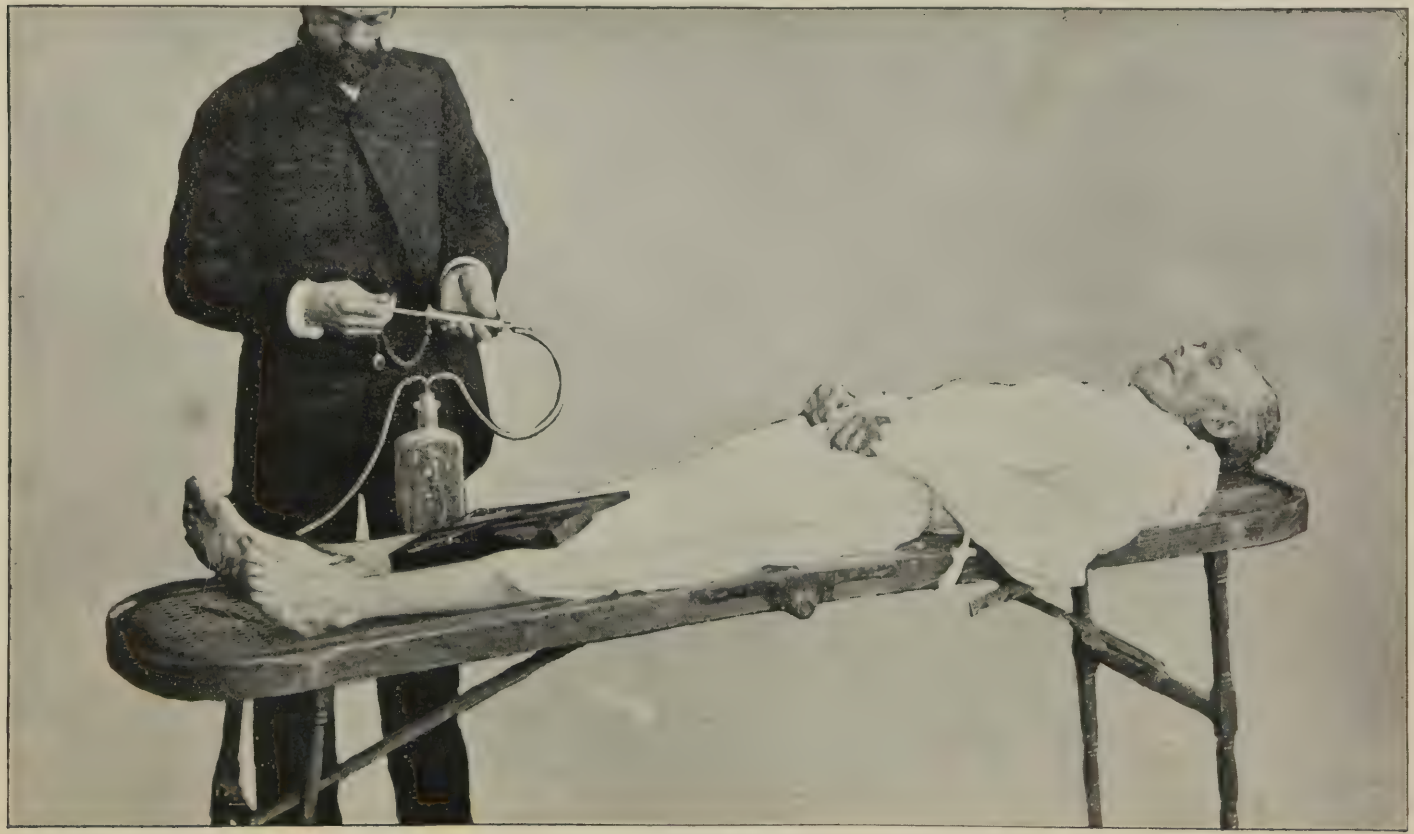
Frequent use should be made of hot, dry woolen cloths to assist in permanently and quickly removing discolorations, particularly from the nose, ear and chin.

If the discoloration is of the ear, apply the cloths (which should be hot, perfectly dry and made of wool) to the discolored part. This will restore the natural temperature, and will also loosen or limber up the blood and draw it to the surface. Then lance the lobe of the ear from behind, and squeeze out the blood through the aperture made by the lance, by the use of the fingers. Then, when thoroughly removed, cover the wound of the lance with court plaster. The same operation can be used for removing discolorations from the nose. In this case raise the upper lip, and make about three small cuts on its under side. Apply pressure with the fingers as on the ear. By making the cuts on the inside of the lower lip, discoloration can also be removed from the chin. In this case rub upward with the fingers.

In all cases apply the hot, dry woolen cloths freely before using the lance.

PRECAUTIONS TO BE USED IN EMBALMING.

The first thing requisite in embalming the dead body is that it should be properly elevated on the embalming table, not less than fifteen inches above the surface. Ascertain the condition of the body, and, if all right, proceed to inject it at whatever point has been determined upon. See that the fluid is entering the body, and not running down on the floor or cooling board. Do not hurry, as the injection is necessarily a slow process. Always draw off the blood, or as much of it as you can get, out of the large



OPERATOR INJECTING THE POSTERIOR TIBIAL ARTERY.

(See page 90.)

vein accompanying the artery. In all cases where there is the least sign of discoloration, use the methods for removal already described. Withdrawal is not necessary in cases of thin blood with no discoloration. When injecting an artery, be sure that the nozzle is properly inserted into its canal, and not between its coats or tunics. This sometimes happens, with a result disastrous to the embalmer's comfort. Be sure that your ligatures are properly passed under and around the arteries and veins, one at each end, making four in all, and also that the ends of the ligatures are in a position to be grasped when needed for tying purposes.

Great care should be taken that the cavities are not disturbed previous to the arterial injection. There is danger that one of the arteries may be punctured in this operation, and the fluid allowed to escape. If the bowels are badly distended and the skin drawn tightly over the abdomen, make a light puncture through the skin, and use a blunt needle for extracting the surplus gases, but this should be done with great care, as there is imminent danger of serious damage. Never dress the body until all animal heat has deserted it. As soon as this has gone and the body has assumed a rigid condition, there need be no fear or hesitation, provided that the body has received proper attention with full quota of fluid. When so prepared, dress and place it in the casket provided for its reception, and keep in a darkened room, care being exercised to have plenty of ventilation.

TO EMBALM A BODY ARTERIALLY.

To embalm a body there are certain rules to be observed. They are simple in the extreme, and, once knowing them, you will never forget them.

In the first place, you are supposed to know pretty nearly what was the cause of death. Make selection of the artery to be used accordingly. Place your instruments in such position that you can reach any of them at will. See that everything you may require is in its proper position, even to the most minute articles. Meantime be deciding on your artery, for, while you are selecting and placing your instrument, you will have time to think. Your selections being made, take a seat convenient to the selected artery, and, with a deliberate and steady hand, mark the outline of your incision by cutting lightly through the skin. Having traced your work, force your way through the superficial fascia (or surface fat), taking care not to cut through the many little branches that are ramifying through it. When you have dissected down through the superficial fascia, you will come to the deep fascia. These fasciæ are a protection to the arteries during life. Dissect through this, using the handle of your scalpel where you think there may be danger of cutting into any of the branches. After passing through the skin, the superficial fascia and the deep fascia, you come directly upon the muscles of the parts which are placed in their positions as safeguards to the artery. The artery being in most cases very deep seated, you will need to exercise great care in selecting your point of incision. You must locate the two edges of the muscles through which the artery passes, and separate them either with the handle of the scalpel or with the fingers, which are by far the best instruments for this purpose. You will find these muscles massed together, as it were, and running parallel with each other, perhaps half a dozen or more. Make your selection out of the bunch, using the fingers of one hand, and pressing down with them a few inches distance from

the point which you have selected for raising the artery, thus forcing the blood in the veins and in the artery to the point of selection, where you can see it flow through the opening. You can then easily distinguish it by its lighter red or pink color, the veins showing a very dark brown, black, or perhaps a deep-blue color. Arterial blood is aërated by the lungs, and oxidized by the oxygen of the body, giving it a light pink tinge, so that mistakes can be made only through carelessness.

After you have made selection and separated the artery partially from its surrounding of fat, tissues, and accompanying veins, with perhaps a nerve or two, place an instrument of some kind, it is immaterial which one, under the artery, and, using gentle force and due caution, separate it entirely. Then, while your instrument remains under the artery, run your fingers across it, feel of it, and thus make sure you have made no mistake. You will soon become accustomed to the feeling of the artery, and, after a little experience, can select it by the touch alone. Next raise it to the surface, due care and caution being used here lest you rupture some little branch or vessel, causing the blood to ooze out, making the operation very tedious and troublesome. Care only is necessary to prevent such accidents. After you have brought the artery to the surface, make another examination, for you cannot be too sure. Place the handle of an instrument underneath, then make your incision, exercising care not to cut all the way and sever the artery entirely, when each end, by reason of its elasticity, would withdraw out of sight. The surest method is to take your index finger, and pass it under the artery, removing the handle of the instrument previously placed there, and holding the artery in an extended position on the end of finger. Take the point

of your scalpel, and prick the artery well up in the direction opposite from that in which you are about to point your tube, so as to leave you plenty of room in which to work. Prick the artery gently at first, remembering all the time that your finger is on the opposite side, and sure to get the benefit of a *cut* if you are too ambitious or nervous. These cuts are dangerous affairs, the wounds being poisonous at times, and very serious. Then extend the " nick " a little, until you have penetrated through the three coverings or coats, which are exceedingly tough. Work your way gently, and you will eventually penetrate the true canal. As soon as you do so, in all probability you will see a drop of arterial, or light-colored blood, ooze out, and a small clot extending inside for about an inch or so. Remove this with your forceps, and let the handle of the instrument replace your finger. This completes the work of raising the artery. Your next step is to prepare the tubing, selected according to the size of the artery chosen, and insert it in the opening. Insert the tube well into the artery, pointing toward the head if one of the lower arteries, and toward the feet if it be the carotid. Then pass a ligature or thread around it, and tie perfectly tight. Have no fear of cutting the artery with the thread if you use no more than ordinary exertion. Then pass a ligature or piece of thread around the other end of the artery well up, and leave the ends of the strings in such a position that you can pick them up at a moment's notice. But you should never tie this upper end until you are satisfied that the embalming fluid is leaking, which it will do after a short time, thus proving to you that the lower part of the limb or the upper part of the head has received its proper quantity. However, as soon as you see the fluid escaping from this point, tie it fast and put the ends

of the string out of your way, cut them off or place them inside the wound. Now, all preparations being made, you are prepared to inject the body. Let us suppose that the back part of the artery has not as yet been ligated, but everything in readiness for the second step in the operation of embalming, the first step, *i. e.*, that of raising the artery, being completed. Should there be leakage of blood from the artery, let it flow, and assist it if possible by occasionally passing the hand or fingers over the surface of the arm, leg or neck. After the contents, clot and all, have been forced or drawn out, take your pump or injecting apparatus, and attach it to the tubing already placed in the canal of the artery. When all is in order, take a small piece of string (a strip of old muslin is better), and tie around the arm or leg, as the case may be.

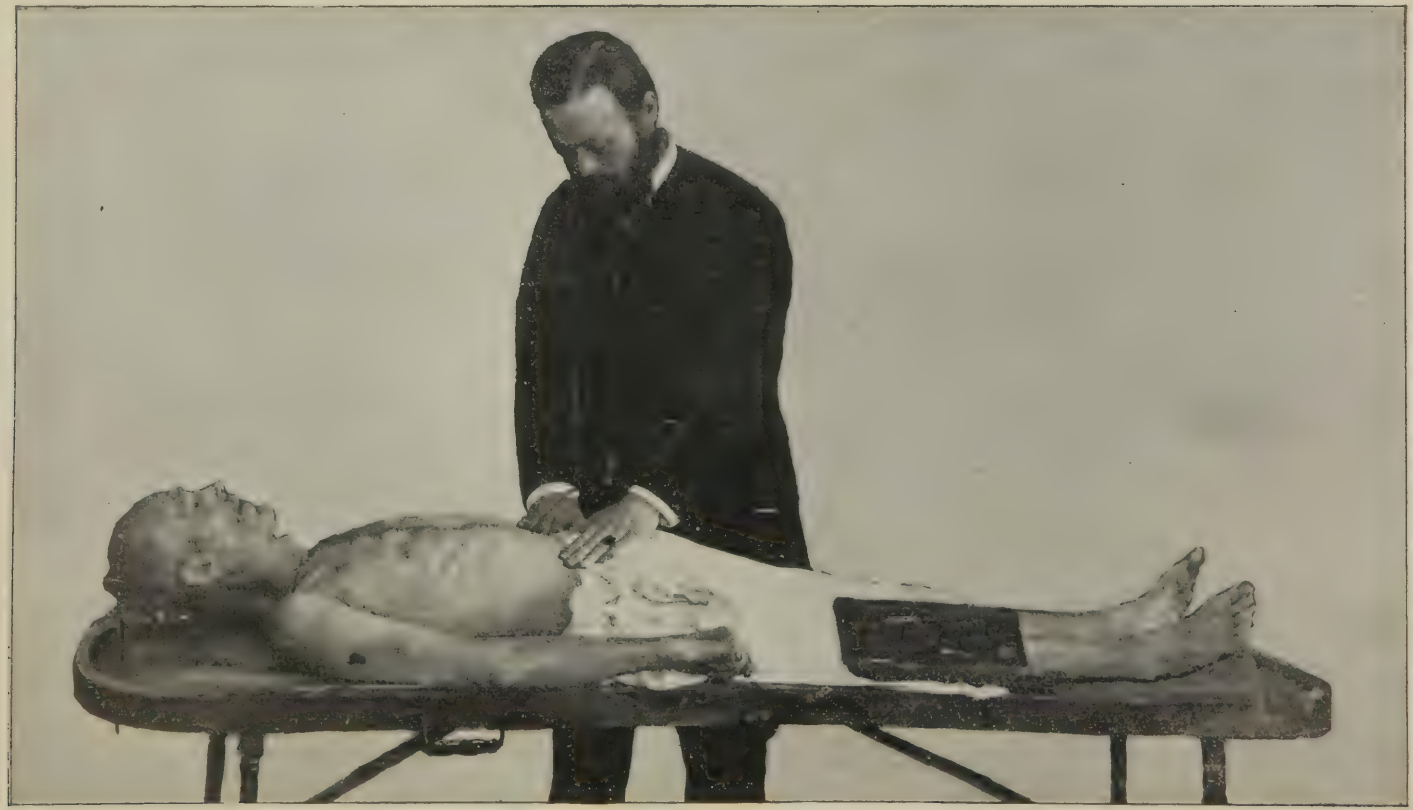
ARTERIAL EMBALMING COMPLETE, OR HOW TO EMBALM A BODY THOROUGHLY.

The first duty to be performed is to remove the body from the bed to the embalming table, which should stand perfectly level. Remove all clothing at once, except that over the loins a sheet should be laid in order to prevent exposure. Turn the head well over to one side. Lend all possible assistance to the purging of the body, emptying the stomach of its contents, if possible, by pressing on the lower ribs over the stomach with both hands, bringing the ribs together and pressing downward at the same time. Wash the body thoroughly, using a small quantity of fluid with the water (hot or cold). When this is completed, and the body thoroughly cleansed, raise the board to an incline of about twelve or fifteen inches, the head elevated, the feet lowered, the object being to promote gravitation. Then, beginning with the

eyes, using your hypodermic syringe, inject under each eyelid and around the ball of the eye, closing them entirely when the operation is completed. Place a small bit of paper extending from the upper to the lower lid, and close the lid over it. Next inject the nose through the nostril by means of a nasal tube or large catheter, passing it well into the nostril, and injecting a small quantity into the lungs by this channel. Then pass the same instrument into the mouth, and inject about one pint into the œsophagus. If you get a quart into the stomach by this means, it is all the better. If, however, you cannot force the fluid into the stomach readily, create an artificial deglutition, or act of swallowing, by passing one hand under the neck and raising the neck and head, allowing the back of head to hang a little lower down, then with the other hand seize the epiglottis, or Adam's apple, and work it upward and downward until the fluid passes. Success generally follows. Next withdraw the tube, and detach it from the pump. Now select an artery for injection. The artery should be selected after the cause of death has been learned. Having chosen with which artery to operate, dissect down until it is exposed to view; then raise both the artery and the vein together, after which separate them, fingers taking the place of instruments. Having separated the artery from the vein, pass a ligature under each end of the artery and vein, allowing the ends of the ligature to hang over the wound, each on its own side. Then raise the artery over the handle of an instrument, or, what is better, over the finger, and "nick" it with the knife point, making a puncture sufficiently large to receive the tube which has been selected. Introduce the tube into the canal of the artery, and tie one of the ligatures around over its head, tying it

very tight to this end, using two or three hard knots. Then " nick " the vein accompanying the artery, and allow the blood to escape as fast as possible, generally assisting it by passing the hand over the surface of the skin above the vein. Attach the pump to the nozzle, or tube, and inject some of the fluid, very slowly at first, thus increasing the flow of blood from the vein. As soon as the fluid begins to issue from the vein, or the blood becomes lighter in color, cease pumping, and tie up both ends of the vein, and allow it to sink into its original position. Then proceed with your arterial injection until the fluid flows from the back end of the artery. Then stop pumping again, and tie that end (back end) firmly with a hard knot. Now, go on with the injecting again, but very slowly, as you must by this time have forced considerable fluid into the arteries. You must now be on your guard. Watch closely the face and head, that it may not become bloated. This is most important, and such a result is to be sedulously guarded against. Care will prevent it. The operator's judgment must decide when to stop. If it does not, he will soon be enlightened, although he should not be startled should the body mottle all over. That is a good sign, and should always be welcomed as a sure evidence that the body is thoroughly injected. We now proceed a step further, and either tie up the artery or put a stopper in the tube. If but a few days' preservation only is desired, tie the artery. If a longer period is sought, plug the tube so that it may be used again the following day, when another quart or two of the liquid should be injected into the artery. Leave the plug in the artery should there be any doubt, and leave the artery in such a condition as that it can be used often in cases where the body is to be long preserved. If, however, the body

is to be kept for a few days only, tie the artery firmly, cut the tube loose and draw it out, letting the artery sink into its original bed. Should there be any leakage from any of the parts, tie them securely. Do not, however, sew the wound up as yet. There are other duties to be performed and of greater importance. Now introduce your hollow perforated needle into the abdomen about two inches above the umbilicus, or navel, and, keeping its point near the surface, penetrate the thoracic cavity through the diaphragm, following the point of the needle with the disengaged hand. Direct the point toward the nipple of the left breast, then force out whatever gases you may find there by pressing down on the part with your free hand. Repeat the operation on the other side (the right breast), withdrawing the needle outside the line of the diaphragm, but not withdrawing it altogether, the one entrance into the abdomen serving all purposes. Having finished this operation on the right side, attach your pump to the needle, and inject about one quart of fluid into each cavity separately, as they are partitioned off by a septum, and hence require separate treatment. This will complete the upper cavity work. Now withdraw your needle from the upper cavities, but not out of the abdomen, having first detached it from the pump, and turn your attention to the abdominal cavity. Entrance to the stomach is gained through the puncture already made in the abdomen. Point your needle to the left and toward the under part of the last (lowest) ribs; you will thus reach the stomach. A strong odor will immediately escape from that organ. Give the gases free egress. Propel the point of the needle into all sections of the abdominal cavity, puncturing holes in the organs and intestines, right and left. Do not fear



OPERATOR FORCING GAS FROM THE ABDOMINAL CAVITY AND STOMACH—LARGE NEEDLE INSERTED.

(See page 110.)

to do harm, but persevere until you are sure that all the gases within reach of your needle have escaped. The abdomen will now be very soft and flabby. Next attach your pump to the needle, and continue injecting the fluid until the abdomen assumes a tight, drum-head appearance. Detach the pump, when more gases will escape, having been driven to the surface by the fluid. Assist its passage in every way. A small quantity of fluid may escape at the same time. Send the needle once more into every corner of the same territory, and introduce more fluid. Finally withdraw the needle entirely after having detached it from the pump, leaving the aperture open. Now return to the artery, and sew up the wound, after which wet some pieces of old muslin, and place them over the abdomen for disinfecting purposes; also cover the face and hands with the same material. Raise the hands onto the breast. The fluid applied to the face and hands should be diluted, making the mixture half water and half fluid. You can now rest assured that your work has been well done. Re-arrange the room, making it quite dark, but allowing plenty of ventilation. Cover the body with your canopy, and return home. Look over your instruments, clean, and arrange them in their respective places, fill your bottle with fluid, and you will be prepared for your next case.

DIRECTIONS FOR ORDINARY OR CAVITY EMBALMING.

If the weather be ordinary, warm summer weather, and you have a case of consumption, or where the body is very much emaciated from a lingering illness, *common cavity embalming* will suffice if the body is to be kept for two or three days only. Your mode of procedure should be as follows: First place the body on a cooling board,

and promote purging from the mouth by using considerable pressure on the ends of the ribs at the lower point of the thorax over the region of the stomach, turning the head to one side, and having the body on a level. After this operation is complete, cleanse the mouth and raise the body to a half-sitting position, or, say, from twelve to fifteen inches. Wash it thoroughly, using one-half water and one-half fluid for this purpose, then extract the gases from the thoracic and abdominal cavities by means of the long, blunt, perforated embalming needle ; the upper or thoracic cavities being emptied of their gases first, later the abdominal. To do this properly, puncture a hole about two inches above the umbilicus (or navel), and direct your needle to the right nipple of the breast. Then manipulate it, *i. e.*, move it about in the cavity, and the gases will escape. Press slightly on the breast to expedite matters. Withdraw your instrument, and direct it this time toward the left nipple, and repeat the manipulation. Never, however, draw the needle entirely out between the two manipulations, as the one puncture should answer all purposes; but be sure to keep your needle as near the surface as possible, as you can then feel and direct it with your free hand. Care should always be exercised here, as, should the needle enter the cavity too low down, the fluid would escape from the upper into the lower cavity, and thus ruin all your work. It does not require great skill to perform this operation, but does demand care. Let your needle remain until you have injected the last cavity. A quart in each of the upper cavities, making two quarts in all for the thorax, will ordinarily be sufficient. There is a septum, a division, separating these two cavities, making two injections necessary. Now withdraw your needle from the upper cavities, as you will have

flooded the parts, thus preserving them as well as if they were inclosed in a vessel or bottle.

On withdrawing the needle from the upper cavities, direct it into the stomach, and extract the gases from that organ; and so on throughout the whole cavity of the abdomen, pointing and puncturing in every direction. Be sure to puncture the intestines thoroughly, both the large and smaller ones, so as to be sure of unloading the gases from all the parts. While puncturing with one hand, pass the other over the parts where the needle is being driven, and press down on them until the abdomen becomes soft and flabby. This condition will serve as your evidence that your work is properly done. Refer to the plates of the Aid for the location of the stomach if you are uncertain. It is located on the left side, under the lower ribs. Next inject the fluid, causing your assistant to do the pumping while you direct the needle. Point it straight into the stomach, and force, perhaps, a half-pint of fluid into that organ. Then withdraw from the stomach, and continue your course all around the abdominal cavity. The punctures made into the intestines will admit the fluid, and you will thus completely saturate the entire cavity, filling it to its capacity. When you have injected a quart, or a quart and a pint, detach your needle from the pump, and allow the gases that have been driven to the surface to escape. Assist them by passing the hand gently over the whole surface. After completing this operation a second time, inject more fluid ; possibly a quart can be injected into the space made vacant by the passing off of the surface gases.

Now transfer your operations, and inject a small quantity of the fluid down the throat and through the nostrils. To do this, introduce a nasal tube or good-sized catheter

down the nostrils into the passage, then attach the pump and inject a limited amount, say a half-pint. If the fluid will not pass down readily, seize the Adam's apple, move it down and up, and, placing the other hand under the back of the neck, raise it, when the fluid will at once disappear down the passage into the lungs, and into the œsophagus, which is the canal by which the stomach is reached. Having now thoroughly embalmed the cavities, you may feel pretty sure of success, but it is always well to obtain some old pieces of muslin from the family, an old sheet for instance, the older the better; saturate with the fluid, and lay over the abdomen, covering from the lowest part to the highest; then lay a dry piece over the whole to prevent soiling or dampening the clothing. This will also act as a disinfectant, and guard against odors that might arise from gases accumulating in the cavity. Leave the puncture open, that the gases may escape into this first outer piece of saturated muslin. It will absorb and destroy them, and also bleach the body to a certain extent. In any event, it is a good plan to follow, and causes no inconvenience, even should it remain under the clothing with which the body is dressed. I have used it successfully, and can recommend it to all as a valuable addition to temporary embalming. Next pass to the bleaching of the face and hands. For this purpose use the same fluid, but reduce to about one-half of its ordinary strength, *i.e.*, about one pint of fluid to a pint of water. Place in a bowl under the cooling board. Saturate a small piece of muslin (though a cotton mask is far superior, as it conforms to the features better), place it on the face, and spread all over it; but be sure the tip of the nose is not flattened, and see that it is thoroughly wet. Lay it very smoothly, so there may be no wrinkles. Next

wrap the hands in the same manner (muslin answers this purpose better than cotton), then place them on the breast to prevent discoloration by the blood which is gravitating downward. Leave the bowl of fluid mixture under the board. Cover the body, leave it on the same incline, darken the room, and see that there is ample circulation of air. Return the next day, and look over your work. Saturate your pieces of muslin and cotton again, and prepare the body for the casket ready for its interment. These directions are positive, and, if carried out, will, under ordinary circumstances, prove effectual. Yet this method of cavity embalming is not recommended by practical embalmers, as failures are frequent, and it requires about the same time to accomplish as does arterial embalming. Arterial embalming is recommended even in the simplest cases. Do not assume, however, that cavity embalming is of no value. It is often of great importance, and is successfully employed by many embalmers in cases of urgent haste.

LONG TIME EMBALMING.

To embalm a body so that it will not change in appearance for an indefinite period, requires an experienced hand, an adept in the profession, and he is required to have good judgment, steady nerve, and a head full of strong common sense. But, if the following directions be followed to the letter, there need be no hesitancy on the part of the embalmer. In the first place, then, the body, having been removed from the death-bed to an embalming table prepared for its reception (which should be on a perfect level), should be disrobed of all its clothing so as to be wholly nude. Wash thoroughly with a solution of embalming fluid and water (warm or cold), after which

throw a light sheet over the loins and extremities. The eyes should then be injected by means of the hypodermic syringe, and then carefully closed, using eye-caps or strips of paper, extending from the upper to the lower lids, with the lids closed over them, care being taken that no folds or wrinkles are in the paper.

Then a nasal tube should be passed into the nostrils, and fluid injected through them into the windpipe, so that it may reach the lungs. One pint of fluid will suffice. Then the tube is to be withdrawn and placed in the mouth, that the œsophagus, or gullet, may be reached. A pint of fluid will probably be sufficient for this, but the operator's judgment must guide here, as there can be no inflexible rules laid down as to quantities, because of the variations in the size of the human body. The fluid introduced into the mouth will enter the alimentary canal, and pass down into the stomach, embalming the passages in its course. If, however, the fluid does not flow down easily and of its own accord, create an artificial deglutition (act of swallowing) by passing one hand under the back part of the neck and raising neck and head about two inches from the level of the board, using the other hand to work the epiglottis up and down. In this way the passage will be opened, and the fluid slip down. Having completed this operation, which, by the way, is a very important one, elevate the body on the table to a height of about fifteen inches, and proceed to raise the right common carotid artery and the large jugular vein, bringing them both to the surface. Separate them from each other and their other adherents, permitting all the extraneous matter to drop back into the cavity you have just made, but keep the artery and the vein at the surface. Pass a string (or ligature) under each vessel. Drop either end of the string, and permit them to hang

where they will be in reach. Place the tube in the canal of the artery with its smaller end directed downward. Make that end of the ligature (or string) fast, that is, at the end of the tube, tying it securely in two or three hard knots, thereby securing the tube in the canal. After this tap the large jugular vein directly in its middle, and promote the flow of the blood from the head, face and neck by pressing your hands over the cheeks and along the side of the neck. Then attach the pump to the tube, and proceed to inject very slowly at first. The fluid, entering the carotid artery, distributes itself through all the arteries and their branches at once, and prompts the flow of blood from the jugular vein, which is just what is desired. Keep up the motion of the pump, working it slowly and still more slowly for a short time, yet making sure, by watching the course of the arteries, that they are receiving the fluid, keeping an eye meanwhile on the jugular vein. When the fluid begins to flow out of the vein, tie at both ends, and dispense with it at once, letting it drop into its cavity. Now proceed with the arterial injection, progressing very slowly, as the fluid must be given opportunity to enter the minute capillaries and veins. As they receive the fluid they become distended, but the process is slow and tedious. Plenty of time and patience is required. About every five minutes stop the pump entirely and make a thorough examination. See if the superficial veins are at all distended. If so, give the pump a few minutes' rest, but continue your vigilance. If all parts of the body appear to be right, start the pump again, but gently — no sudden motion must be allowed, your object being to reach all parts of the body through the arteries, capillaries, and veins, with as much smoothness as possible. Continue to pump until you have

injected an amount of fluid which, according to your judgment, is sufficient for the time being.

Then detach the pump from the tube, and place a cap or stopper over the tube-end to prevent the escape of the fluid. Leaving the artery for a time, proceed to embalm the upper and lower cavities of the abdomen, extracting all the gases which they contain before injecting the fluid. To extract all these gases, it is necessary to puncture all the internal organs. Enter the right thoracic cavity through the diaphragm by making an incision two inches above the umbilicus (or navel), and direct the needle toward the right nipple. By pushing and withdrawing the needle an inch or two alternately (thus puncturing the surrounding parts), you will extract the gases through the hollow of the needle. Now withdraw the needle from the right upper cavity (but not from the abdomen), and direct it toward the left nipple. Remember never to draw the needle out of the puncture you have made above the navel; but, when you have treated the left upper cavity, then withdraw the needle from this upper region (but not out of the entrance aperture), and direct it toward the stomach (on the left side). Puncture its walls, and allow all its gases to escape through the needle, holding a sponge partly wet with the fluid over the end so as to neutralize the odors that arise from the organs as they are penetrated. Skirmish with your needle in every direction. When you have punctured all the parts, intestines included, and have returned with the instrument to your starting point, do not withdraw it, but re-enter the right thoracic cavity, and inject as much fluid as it will conveniently contain. Do the same with the left cavity. Next draw the instrument out of the left cavity, and direct it in a straight course under the sternum (breast bone), and puncture the heart.

If any blood issue out of the needle, allow it to run its course into some vessel or empty bottle.

Let me repeat, keep your needle as near the surface as possible, so as to avoid any leakage from the upper into the lower cavity through the holes you have made into the diaphragm. Now pump fluid into the heart and its surrounding cavities, and duplicate your work by so doing in the upper cavities. Withdraw your needle again from the diaphragm, and direct it into the stomach, straight through its walls, and inject fluid into its cavity. Continue this operation all around, as you did when puncturing the organs and intestines for gases. Use your own judgment as to the amount of fluid to be passed into the cavities, as you did in the case of the arteries. Ordinarily you should use, altogether, about six quarts on the first day. You next withdraw your needle part way, and permit the surface gases to escape. Probably they will pass off in large quantities. Then take some old muslin or towels, and saturate them thoroughly with the fluid, and lay them over the whole abdominal surface next the skin. Now wrap the hands in two or three thicknesses of muslin saturated with the solution made for facial applications. It should be one-half fluid and one-half water. Dip the cloths in this solution, which should be kept in a bowl under the embalming table. Make a mask of cotton, and saturate with the solution. Place it over the face, fitting it to the parts by pressing it in and around the nose, and down upon the eyes, extending it from the top of the forehead to the chin, and down the neck, and from the back of one ear to the back of the other. Tie or pin the hands to the night-dress above the breast. Do not allow them to lie by the side of the body. Leave the room in good order, and the body in the same position. Shade the

windows until the room is dark, and see that there is a full circulation of air. Assure the family that all is right, and state that nothing must be disturbed, and under no circumstances can the removal of the mask be permitted. Never remove it until you call the next day, as it is better to keep the air from the face and hands for the first twenty-four hours.

On your return the next morning remove the mask, and see that all is right about the face and hands: saturate it again: make thorough examination of the body: see that the tube you left in the artery is in position, and that there is no leakage anywhere. Call again in the evening, and make another thorough examination, and wet the mask again and leave it for the night. Call again the second morning, and bring with you more fluid and your instruments; inject the artery again with perhaps one or two quarts, as the case may be. Look to the cavities, introduce your blunt needle, and manipulate it in all directions. Extract whatever gases have accumulated in the meantime; be sure of a thorough and complete examination, slighting nothing, even to the minutest detail. Withdraw the fluid from the cavity by means of your pump (as in dropsy), and introduce a fresh quantity, perhaps one to two quarts, thus destroying the possibility of more gases accumulating. Replace the saturated towels, and see that the tubing in the artery is all right, well plugged with a piece of muslin around it, and leave it until the following day. See again to darkening the room, and continue the circulation of air, leave all in good order, and call the next day. By this time, all arrangements having been made for the funeral, you will be notified to that effect. Govern yourself accordingly. If there be no particular haste about dressing the body, leave every-

thing as it is until you are ready to dress it for the casket. Then make your final examination, and, if any repairs are to be made, make them now, as this will be your "last opportunity." Just before dressing the body, saturate the towels that are on the abdomen, and leave them there. Put clothing on over them; sprinkle a little fluid around the bottom of the casket, among its linings, or place some within at the foot, or do both. You might use the mask for face again if there is no glass to keep the air out. This is quite an important duty, as air will cause a change in some cases; therefore it is well to be on the safe side, and preserve the mask for use at any chance opportunity that may come to you as at night time, removing it in the morning. If everything is in order, as it should be, proceed with your final preparations, and assure the family that all is well. The body can now be kept almost indefinitely, and may lie in state, be transported from place to place, or be shipped across the ocean and back. It should be in a perfect state of preservation, and will not change in any way, if the face be kept from the air. Keep a glass over the upper portion of the coffin.

HOW TO EMBALM A CASE OF CONSUMPTION.

First inject the brachial artery, after having performed the usual preliminaries, such as assisting the body in its purging, elevating it on the board, etc., which are the preparatory necessities in all cases of embalming. Let the blood escape from the vein at the same time, as that will relieve the heaviness frequently seen about the neck or face — an appearance like bloating. Usually the arteries of one dead from consumption will absorb a full supply of fluid, because of the thinness and scarcity of the blood. Care should be exercised, as in many cases of

consumption the lungs have become decayed. Such cases require prompt attention. Then, there are the variations of the disease — consumption of the bowels, lingering consumption, hasty consumption — all these cases require special care. The contents of these emaciated frames is generally a mass of decomposing material, forming gases and threatening the whole body with premature decay. Such cases are desperate ones, and require prompt and heroic treatment. The brachial artery is preferable for this class of work, as the fluid is easily forced from it throughout the entire system. Follow the injection of the artery with the customary treatment of the thoracic cavities, perforating the diaphragm from the point over the navel as usual, and inject at least a quart of fluid into each cavity, or more if you can do so without swelling the chest walls. Then do with the abdomen as directed in case of regular embalming. Extract the gases, and inject with fluid. If properly embalmed, a consumptive body may be preserved for a week or ten days as readily as for two or three days. The embalming process in cases of consumption improves the appearance of the dead. Arterial embalming should be employed in all cases where decomposition has set in. Ordinary or cavity embalming may be used on occasions of great haste; but, whenever the bowels are the seat of trouble, heroic treatment is required. This is also true in advanced stages of decomposition. Here the abdominal cavity should be treated first, as gases form very rapidly. It is more than likely that, on your arrival at the house, you will find the body purging, the abdomen very much distended, the subject, in fact, decomposing rapidly. Assist the purging already begun. Reach the stomach at once, using all means at your command to assist the escape of the gases, after

which the purging will cease, the body will assume a more composed appearance, and everything move as ordinarily. Embalm through the brachial or femoral artery in all such cases. In fact, whenever the subject is in bad condition, the greatest safety lies in arterial work. A collateral benefit arises from raising an artery in consumptive cases. It is this: that, as there is usually only a small depth of tissue or fat to penetrate, the artery is easily and quickly reached, and a certain familiarity and expertness in the work gained at small expenditure of risk or effort. In such cases practice feeling of, and familiarizing yourself with, the artery. It will be good drill for you.

HOW TO TREAT A CASE DYING FROM PNEUMONIA.

To embalm in cases of pneumonia, follow about the same methods as in consumption. Pneumonia is an inflammation of the substance of the lung. The lungs, therefore, are the seat of the disease, and are the parts to be treated. Use the brachial artery, and inject as you would in any other case. The upper cavities should receive the greatest consideration. Inject toward right and left breasts or lungs through the diaphragm, using the long perforated blunt needle if you can force it through, or make an entrance for it with a pointed instrument. Then do as previously directed in other cases.

Pleurisy can be treated in the same way, as it is closely allied to lung diseases, and oftentimes, in fact, pneumonia develops into pleurisy. In such cases there is a pleuro-pneumonia, which may be treated in the same manner.

To embalm a body dead from either Heart Disease, Alcoholism, Paralysis, Poisoning or Sunstroke, proceed as in Pneumonia.

HOW TO EMBALM A BODY DEAD FROM TYPHOID FEVER, AND LOW TYPE FEVERS.

While on our guard at all times, in low type fevers we should be especially so, as they are difficult cases to handle. Heroic treatment from the beginning is required. Disinfect the room upon entrance with any one of the various disinfectants. Sprinkle spray all over the body, bedding, furniture, and carpets; in fact, scatter your disinfectant indiscriminately. A body dead from typhoid fever generally emits a discharge from the anus, which should be immediately disinfected, as it is in this that the deadly contagion lurks. Remove at once, and pack something in the anus. Cotton saturated with a disinfectant, and forced into the rectum through the anus, is a practicable method of dealing with disagreeable discharges. But, if that does not suffice, ligate the anus. First having drawn it out with your sharp-pointed embalming hook, pass a string around it, tie it in double hard knots, and let go. You will not be troubled further from this source. Wash and inject the body as in any other case through the carotid artery, but tap the jugular vein as a means of escape for whatever blood will run out. Disinfect it as it runs into a basin by using full-strength fluid, occasionally pouring in a little. If on the following day you should see any change for the worse about the body, remove the fluid from the abdominal cavity and inject a new quantity. To draw the fluid from the cavity, introduce the long perforated blunt needle into the old opening, and reverse your tubing on the opposite side of your pump. Use the pump in the same way as for injecting. In typhoid fever, there is but one thing really contagious, namely, the stool, or discharge from the rectum. Therefore be sure to use pre-

cautions as described. Follow this method in all low type fevers, as they vary little.

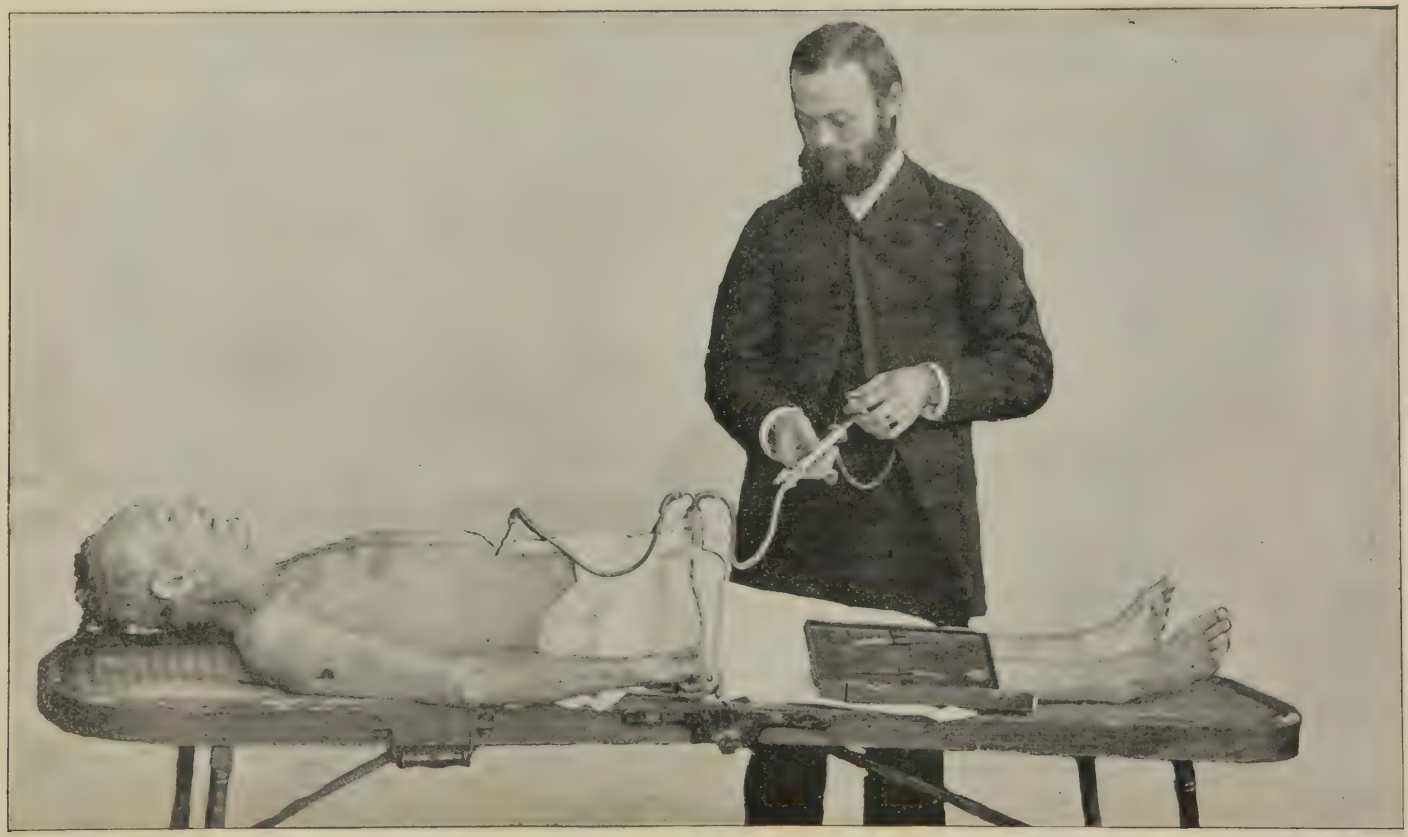
HOW TO TREAT A CASE DYING FROM A HEMORRHAGE.

To embalm the body of a person who has died from a hemorrhage of the lungs, involves the same treatment as in consumptive cases. The body is more easily preserved, however. You are not compelled to withdraw the blood, as this has been already done for you. Simple, ordinary methods answer all purposes, substantial treatment of the cavities being all that is really necessary. But in cases of *Internal Hemorrhage*, you have to apply all the means at your command, for the blood has escaped into the cavities of the body, and prompt and heroic treatment is needed. Draw the blood and water from the cavities where it has settled, if possible, and in all cases, before injecting the fluid.

TO EMBALM A BODY DEAD FROM DROPSY.

These are the most exacting of all cases, and require skill and nerve. First, elevate the body on the embalming table as high as possible without causing it to sit upright. Inject the eyes with your hypodermic syringe, then inject the nostrils, and let the body remain in its elevated position a few moments so as to get all the water (the dropsical fluid) into the abdominal cavity. Take the point of your knife and cut through to the skin, or use your dropsical trocar instead, the only disadvantage attached to that instrument being its sharp point. But, if the case is a bad one, the long, blunt perforated needle is the best instrument by far, and should always be used, because with it there is no fear of rupturing the arteries and spoiling the arterial injection. Pass it hither and

thither, anywhere and everywhere, its great length permitting you to penetrate the abdomen from top to bottom and from side to side. You will extract the gases at the same time that you are extracting the dropsical fluid. Attach the pump to the head of the needle, rigging the pump on the opposite side. It will require perhaps an hour for the removal of the dropsical fluid, the abdomen diminishing in size as the water leaves its cavities. When the dropsical fluid is all withdrawn the abdomen will lap or hang over your embalming board, a very sure sign that you have succeeded in extracting the fluid. Now, raise an artery—the brachial answers very well, or the carotid. If there should be any discoloration about the face, neck, shoulders, use the carotid without fail, and open the jugular vein at its side, tap and let the blood run its course. In fact, while the water is leaving the abdomen, once well started, let it attend to itself and look for the artery, thus saving time, though the operation will be long and tedious at best; yet you should omit nothing. Prepare your ligatures around the vein and artery, and open the vein in the center as you would in any other case; but here you will be obliged to stop, as it is not advisable to inject the arteries while so much dropsical fluid remains in the body. Do not hurry in cases of dropsy, but allow them to take their course. When the abdominal cavity shows signs of becoming empty of water, begin to inject the arteries, still allowing the long needle to remain in the cavity. Inject as slowly as possible at first, increasing your speed as you advance. Inject perhaps from three to four quarts of fluid into the arteries. Care must be taken that the jugular vein is tied as soon as the fluid oozes out. Then care for the case as in any other case of embalming. Should there be no change next day, leave everything alone; but, should there



OPERATOR INJECTING THE PLEURA IN THE THORACIC CAVITY.

(See page 116.)

be much water in the legs, scarify (cut) the flesh just between the ankle and the heel. Cut a deep gash in each foot, and the water will run down through the tissues of the leg, and escape into a proper receptacle, or a rubber blanket which has been placed under the body. It is an excellent idea to fold up the edges of this rubber sheeting, and empty it in the morning. Make several scarifications (cuts) along the inside of the legs, for the probabilities are that water blisters will form, in which case it is better to open them with your scalpel, and let the water escape into the rubber sheeting. When the water is out, bind up the legs, commencing at the feet, and winding closely a piece of muslin bandage rolled for the occasion. Make your bandage about four or five inches wide. Place cotton on the inside, and wind the bandage over it. Use plenty of fluid, even up to two gallons, for inward and outward application. Of course the amount should be gauged according to the size of the body and by its condition.

TO EMBALM A BODY DEAD FROM CHILDBIRTH.

These are difficult subjects to handle. Ordinarily you will need an able female assistant, as there is much delicate work to be done. Immediate attention is required. The arteries should always be used. On no account trust to cavity work alone. Should there be discoloration, remove it by tapping the vein accompanying the artery. Invariably use the carotid or femoral arteries in these cases, as they are large, and the removal of blood a simple matter. Care should be exercised that there be no leakage from the uterus (womb). If there should be, require your female assistant to fill with cotton and close as tight as possible, placing a napkin about the genital organs. Should the leakage continue stubbornly, sew up the geni-

tals, making a very small stitch, and draw your sutures tight. This will control the leakage effectually and permanently. After injecting the arteries thoroughly, proceed to the abdominal cavity, where you must be very particular, and equally so with the thoracic cavity, as both are involved in the disease. The upper includes the breasts, which are full of glands and veins containing milk, which requires immediate attention, as the gases will form very rapidly. Always gravitate the body, raising it high up, and keep it in that position until ready to be placed in the casket.

In case the child remains in the womb after the death of the mother, it need not be removed, as it will be embalmed at the same time and through the same arteries as the mother.

TO EMBALM A CASE OF PERITONITIS.

In cases of this nature, use either one of the most important arteries, and proceed as in ordinary cases. The seat of this disease is the bowels or intestines, and without doubt they will be badly distended with gases and need immediate attention, as the skin is becoming discolored, and it will readily appear that decomposition has set in and must at once be arrested. First, then, open the cavity and extract the gases, which will come out with a great rush, and be very offensive; therefore, have your disinfectants ready, and destroy all odors as they are expelled from the body. These gases are in some instances extremely poisonous, and always disagreeable, therefore neutralize them at once. Inject all the fluid possible into this cavity, and cover with the pieces of muslin thoroughly saturated with fluid. It will probably be necessary to extract the fluid on the following day, and

replace it with a fresh supply. Do not trust to cavity work alone in bad cases, no matter what the cause of death may have been, even though the body is to be interred the following day.

HOW TO EMBALM A BODY DEAD FROM GUN-SHOT WOUNDS.

Locate the wound, and probe for the ball if it has not been already extracted. Ascertain whether there has been much hemorrhage, and also if any of the arteries have been severed. You will know what course the arteries take by a reference to the plates of the Aid. Ascertain also if any of the viscera, and what part, have been penetrated. Inject fluid into the wound, and let it run out, or, if it remains in the wound, you will know that the bullet has entered and lodged in one of the cavities of the body, and left a canal to its bed. Then place a wad of cotton in the wound, and take a stitch or two in the opening, thus closing it, and imprisoning the fluid you have injected. If the ball has entered the head, use the carotid artery (19, Head section, Aid). By all means tap the jugular (16, Head section, Aid), and force out all the blood possible, and then embalm the body as you would in any other case, and follow the directions given for embalming through the carotid artery. These are not difficult cases, as hemorrhage has saved time that otherwise you would have to expend.

TO EMBALM A BODY DEAD FROM DROWNING.

First empty the body of the water that has passed into it during its period of immersion. In cases of drowning, the blood remains fluid, and decomposition begins at the head and works its way downward. Make an incision in

the side of the abdomen to let the water and gases escape, cutting through the skin only with the knife. Use the long, blunt needle for extracting purposes. Force all the water out of the body, then proceed as in any case of arterial embalming. Use the carotid artery so as to utilize the jugular vein for removing the blood. Puncture the stomach and bowels in the lower cavities, and the pleura in the upper, then inject with perfect freedom. Cover with saturated muslin, as usual, and place the body in its casket. Keep cloths on the face until a few hours before the service. Dress the body of a drowned person as soon as it is embalmed, as it will not be necessary to disturb it. Where the skin is falling off, as sometimes occurs when the body has been long in shallow water, prepare it for burial quickly as it will be impossible to make the body presentable.

TO EMBALM A BODY DEAD FROM APOPLEXY OR FROM SUFFOCATION.

In all cases of suffocation the body will be highly discolored, and especially at the upper extremities. Therefore, after raising the carotid artery, introduce the tube, and, making it fast, open the jugular vein at the neck with the point of the knife. A good-sized slit being made, allow the blood, which remains fluid in these cases for a very long time, to escape into a basin. When it runs slowly, assist it by passing the palm of the hands over the head, face and neck toward the opening in the neck. Begin your injection, and so force the blood to some extent. Then proceed with your work, following the rules already laid down. The arteries are always to be used in these cases, no matter if the body is to be kept but one day.

IN CASES OF DEATH BY STRANGULATION OR FROM A BROKEN NECK,

the same process should be followed. These subjects are always discolored in the face and upper parts, but the blood remains fluid, and will gravitate toward the feet if the body is left on an incline. Suffocation, hanging and strangulation can be treated alike. Sunstroke and apoplexy are in about the same category. Use the same method in all. Remove the discoloration, and use the same artery and vein.

TO EMBALM A BODY WHERE THE THROAT HAS BEEN CUT.

If the common carotid artery has not been severed, cut down to it, and use it as in any other case. If this artery has been severed, then tie the upper end, and insert your tube in the lower end, and inject the fluid downward.

TO EMBALM BODIES DEAD FROM ANY DISEASE WHERE POST MORTEM HAS BEEN HELD.

As a rule the doctors increase the embalmer's difficulties. In cutting the dead body open, and in examining the viscera, a great number of the arteries and their branches are cut and destroyed. Yet the gases will have been extracted during the post-mortem operation, and should the arteries be in sight, ligate (or tie) the ends, and thus get a circulation. But this is a tedious operation, and requires skill and patience. The easiest method is to raise the brachial artery (A, Upper Extremity plate in Aid) and inject about one quart of fluid, which will mostly enter the head and upper extremities. Then open the posterior Tibial (G, plate 5, in Lower Extremity in Aid) and inject upward. Thus the arteries will be filled. Of course some of

the fluid will enter the cavities, but not all, as the arteries should not be crowded. If it does flow out, it will be a very slow process, and not enough escape to endanger the chances of success. Then saturate the cavities, and, if any leakage takes place out of the genitals, sew them up, and retain the fluid in the body, which will insure its keeping all right. The body in these cases should not be on much of an incline (not more than six inches), as not much gravitation is required. Do not fear failure; let the post-mortem go on, only be sure to fill the cavities.

CONDUCTING FUNERALS.

About one hour before the time set for the funeral, repair to the house with your assistants, and explain to each the duties which you expect him to perform; viz., attending the door, directing the relatives to one part of the house and friends to another, watching that there be no confusion in opening and closing camp-chairs, placing them in position in the rooms set apart for that purpose, never allowing any to remain open in the hallways, receiving flowers at the door, and placing them according to directions. See that services are begun promptly — delay at such times is a cruelty. One assistant should be stationed outside, to attend to the order of the carriages. There should be no loud talking in front of the house. When everything is in readiness, there should be a man at the door to direct the relatives and friends to the carriages assigned them; another at the line of carriages, to assist the family and friends to their seats. When all are filled a motion of the hand should be given to the one in charge

When the cortege moves away, the man left at the house should set the home in order before the return of

the family, removing all evidence of the funeral, carrying his paraphernalia to his office, and laying it aside carefully and well cleaned for future use. One assistant should return from the cemetery, and see to it that the family are assisted out of their coaches. Courtesy, gentleness, unobtrusiveness, thoughtfulness, sympathy — all are requisite to a proper discharge of Life's saddest ceremony.

APPENDIX

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APPENDIX.

THE study of Anatomy, as pursued by the physician, extends over the broad field of all branches of that science; but for the undertaker it is more particularly confined to Angiology, and the histology of those vessels through which the sanguinary circulation is conveyed to all points of the human organism.

Hence, in order to enhance the value of this companion to the Anatomical Aid, for the use of undertakers, and with a view to aid them in their comprehensive apprehension of the embalming process, we here add a few observations of immense practical worth to the student of the Handbook and Anatomical Aid. It is an irrefutable fact, that, if the embalmer is thoroughly conversant with the location and ramifications of those channels through which the blood circulates during life, he must, certainly, according to the sequence of indisputable logic, be familiar with the progress and distribution of the antiputrid fluid which is injected into those same channels for the purpose of preservation.

This invaluable information can be obtained by a careful study of the inimitable plates in the Anatomical Aid; but we shall also supplement this by the addition of a short description of the physiological aspect of these same vessels.

Arteries are tubes which convey the blood from the heart to all parts of the body. They are elastic and strong; have no valves except the three semilunar valves

at their emergence from the heart, and are said not to contain any blood after death. They are formed of three coats or tunics superimposed over one another, and known as the internal, middle, and external.

What deductions can we derive from these statements?

1. The arteries convey the blood from the heart to all parts of the body. If this be the unquestionable case during life, is it not also true that after death, liquid injected into these same arteries must also penetrate to every part of the body?

2. Arteries are elastic and strong. During life they distend under the amount of blood thrown into them by the muscular action of the heart, and also after death they are distended by a precipitate injection of preserving fluid into them. The results of an unguarded manner of injecting fluid may be easily understood, especially if the statements following be taken into consideration.

3. All medical works agree in the statement that arteries contain no blood after death. This must be accepted, but not without a qualification, as it is well known to all undertakers that the insertion of a sharp instrument into the internal coat of an artery is followed by the appearance of blood. Hence this is a certain indication of our penetrating the internal coat and the entrance of the tube of the injector into the vessel, thus preventing that fatal error of introducing the injector between some of the external coats.

4. Arteries have no valves except the three semilunar valves of the aorta where it leaves the heart. Therefore the whole arterial system is open to the free circulation of the fluid.

Notwithstanding the foregoing statements, let us remember that in some cases the arteries contain a large amount

of blood, and the knowledge of this fact must be remembered by the careful embalmer.

Veins are tubes which return to the heart the blood conveyed to all parts of the body by the arteries.

Veins are neither as strong nor as elastic as the arteries, as they are not, except at a very few points, submitted to the strain of the pulsating action of the heart. They contain many valves, especially in the extremities, to counteract the possible effects of centrifugal force in the motion of the legs and arms. They are always full of blood in the dead subject; they present a greater possibility of coagulation of the blood which they contain in their larger trunks than of that in the smaller ones. They are divided into two classes, perfectly exemplified in the Aid. First, the deep-seated veins, which always accompany the arteries, either single or double, and the subcutaneous veins, which pass over the muscles, under the skin, and which communicate freely with the deep-seated veins. The points of injection shown on Plate of Muscles, Nerves, Veins and Arteries, are intended to be used as the requirements of the case demand.

It is beyond the scope of this work to enter into details pertaining more to the teachings of an embalming school than to anatomical knowledge; but the intelligent embalmer, taking advantage of the preceding remarks, and applying them to practical use, in conjunction with theoretical instruction to be gathered from that peerless work "The Embalmer's Anatomical Aid," must become convinced of the unequaled merits of this atlas.

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PART SECOND

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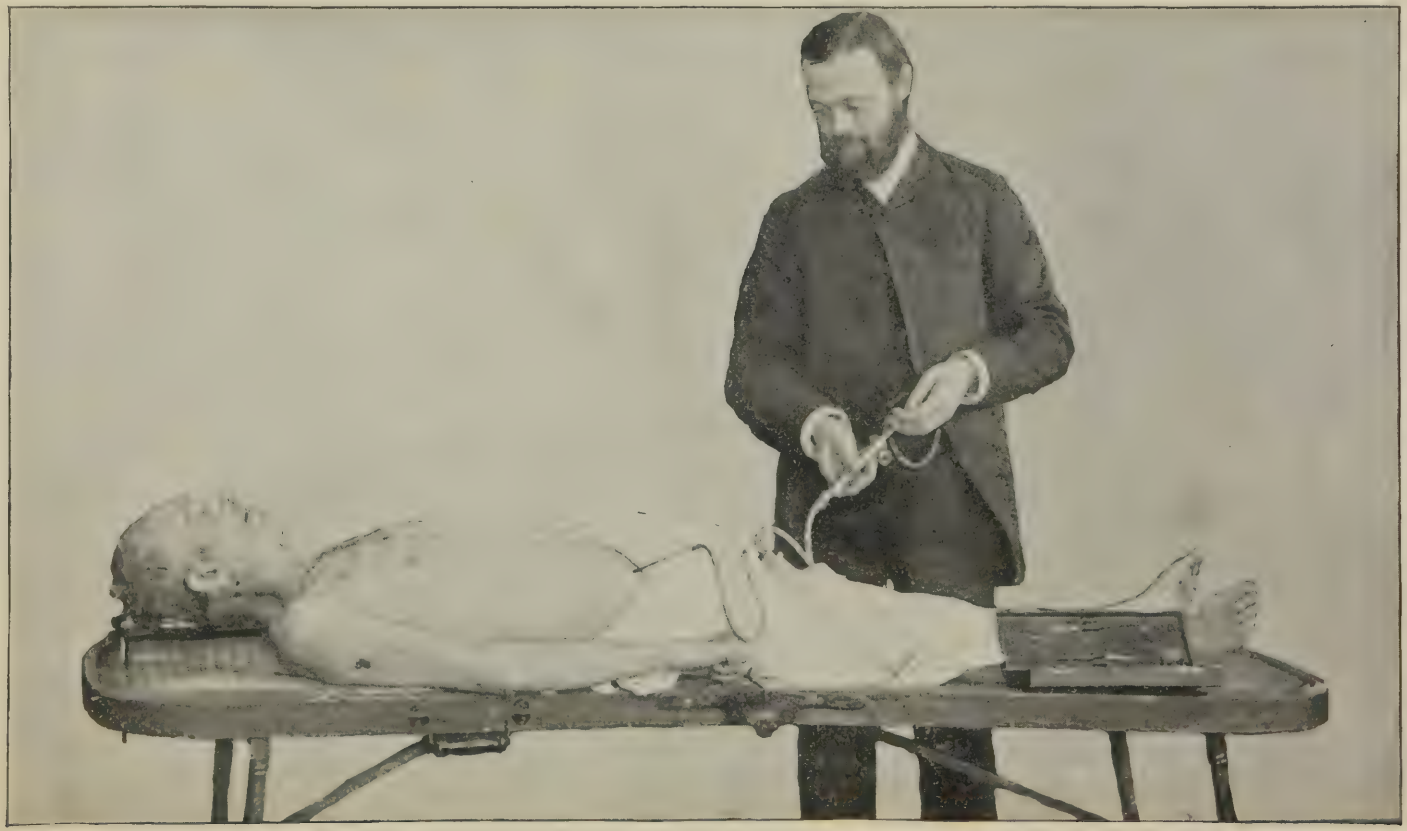


OPERATOR INJECTING THE STOMACH AND ABDOMEN.

(See page 111.)

THE SKELETON.

Letters and figures inclosed in parentheses, in this Handbook, refer to parts or organs similarly lettered or numbered on sections or plates.

INDEX TO PLATE.

(1) Frontal.
(2) Parietal.
(3) Temporal.
(4) Mastoid part of Temporal.
(5) Nasal.
(6) Malar.
(7) Superior Maxillary.
(8) Teeth.
(9) Inferior Maxillary.
(10) Cervical Vertebræ.
(11) Dorsal Vertebræ.
(12) Lumbar Vertebræ.
(13) Clavicle.
(14) Scapula.
(15) Sternum.
    (A) Manubrium.
    (B) Gladiolus.
    (C) Ensiform Appendix.
(16) True Ribs.
(17) False Ribs.
(18) Floating Ribs.
(19) Humerus.
(20) Radius.
(21) Ulna.

(22) Carpus.

(A) Scaphoid.
(B) Semilunar.
(C) Cuneiform.
(D) Pisiform.
(E) Trapezium.
(F) Trapezoid.
(G) Os Magnum.
(H) Unciform.

(23) Metacarpus.
(24) Phalanges.
(25) Sacrum.
(26) Coccyx.
(27) Ilium.
(28) Ischium.
(29) Pubes.
(30) Head of Femur.
(31) Neck of Femur.
(32) Shaft of Femur.
(33) Patella.
(34) Tibia.
(35) Fibula.
(36) Tarsus.

(A) Os Calcis.
(B) Astragalus.
(C) Scaphoid.
(D) Head of Astragalus.
(E) Internal Cuneiform.
(F) Middle Cuneiform.
(G) External Cuneiform.
(H) Cuboid.

(37) Metatarsus.
(38) Phalanges.

THE SKELETON.

The skeleton consists of two hundred bones, excluding those of the ear and the smaller sesamoid bones. The sacrum and coccyx, together, have the elements of nine vertebræ, but are counted as two bones. The bones give outline to the body, and support to the soft parts, form cavities for the protection of the important organs, and serve as levers and points of attachment for muscles in locomotion, and motion of individual parts.

As to their form, bones are classed as long, short, flat, and irregular.

Long bones have three sources of arterial supply: the periosteal vessels for the compact tissue of the shaft; the nutrient or medullary artery for the marrow and deeper parts of the shaft; the articular arteries for the cancellous tissue and red marrow of the extremities. These sets of vessels communicate freely with each other.

In structure, bone tissue is either dense or porous. The former is *compact tissue*, and is found in the shaft of the long bones and the surfaces of all bones; the latter is *cancellous tissue*, and forms the expanded ends of the long bones, and the central part of other bones. Compact tissue is disposed in concentric layers (*lamellæ*). Cancellous tissue is made by these layers separating, diverging and interlacing, the fibers being disposed in the forms of arches, which give elasticity and strength. These arches are always arranged with reference to points of pressure and traction.

Except where covered with cartilage, bones are surrounded by a dense fibrous membrane, the *periosteum*, which serves as a nidus for the subdivision and distribution of arteries to the bone beneath. It sends a sheath with

each vessel. By its under layer, which is gelatinous and contains the osteoblasts, it contributes to the growth, nutrition, and repair of bones.

Histologically, bone consists of bone spaces with their contents, and the bone tissue proper. The spaces are the *medullary cavities*, the *Haversian canals*, the *lacunæ*, and the *canaliculi*. The medullary cavities are the canals of long bones which contain yellow marrow (ninety-eight per cent. fat), and the medullary cavities of the cancellous tissue, which contain red marrow, which substance contributes to the formation of the red blood corpuscles. The medullary membrane (*endosteum*) lines these canals and spaces.

The Haversian canals average 1-500th of an inch in diameter. The larger ones contain marrow, and all convey one or more blood-vessels. The lacunæ are characteristic of true bone, as distinguished from calcareous deposits. They are insect-like cavities between the lamellæ, arranged in circles around the Haversian canals, oval-shaped, and in size 1-2000th by 1-6000th of an inch. Each one contains a soft, nucleated substance called a "bone corpuscle." The canaliculi are the channels by which the lacunæ communicate with each other and with the Haversian canals. Diameter 1-14000th of an inch and less. They contain, each, a minute process of the "bone corpuscle" of the lacunæ. This process imbibes nutrient fluid from the blood in the Haversian canals, and passes it on from one lacuna or "bone corpuscle" to another —thus supplying the bone tissue with nutrient material.

Bone tissue proper, occupies all the space between the lacunæ and canaliculi. It is one-third organic and two-thirds earthy matter. The organic matter makes the

outline and forms a bed in which the earthy matter is laid down as minute osseous granules.

The embryonic skeleton consists, at first, entirely of this animal matrix, for the most part in the form of hyaline cartilage.

Ossification begins by a deposit of bone granules in the matrix, at certain points. Each point is a "center of ossification." These centers are definite in number and in their order of succession for each bone, but vary in different bones.

The skeleton begins to ossify in the clavicle, by a center which appears the middle of the second month of fœtal life.

The primary center in a long bone is for the shaft (diaphysis). After the shaft is well advanced in ossification, secondary centers (epiphyses) appear in the articular ends of the bone. Still later, other centers appear for the processes, tuberosities, etc.

The first epiphysis to appear, and the only one present at birth, is that of the lower end of the femur. This fact is available in determining certain medico-legal questions about premature birth. Soon the diaphysis is separated from its epiphyses, only by a thin disc of cartilage (epiphyseal cartilage). Eventually, they unite and become continuous by ossification of the disc, when the individual has attained full stature. This process is completed in all long bones by the twenty-fifth year.

Of the epiphyses, that one which appears first unites last. The nutrient artery runs toward that epiphysis which unites first. The nutrient arteries run *toward* the elbow in the upper extremity, but *from* the knee in the lower limb.

Bones derive their growth in length from the epiphyseal

cartilages, but not in equal degree from the upper and lower. That epiphysis which appears first — being the one from which the nutrient artery runs — contributes most to the growth in length. Hence, in the upper extremity, the growth in length is derived mostly from the epiphyses at the shoulder and wrist, while in the lower limb those at the knee contribute most.

Growth in length is arrested if an epiphyseal cartilage is destroyed by suppuration, or prematurely ossified by inflammation. The amount of the permanent shortening of the limb resulting, will depend on which cartilage is involved, and whether its destruction has been complete or partial; and if partial, whether on the epiphyseal or diaphyseal faces of the cartilage; for that surface of the cartilage toward the diaphysis contributes about fifteen times more to the growth in length than does the epiphyseal face.

The epiphyseal cartilage, to a certain extent, serves as a barrier to the extension of inflammation and suppuration from one part to the other.

The expanded part of the shaft, between the end of the medullary canal and the epiphyseal cartilage, is called the juxta-epiphyseal portion (Ollier), and from a pathological and surgical standpoint is the most important part of the bone. It is the seat of the greatest physiological activity and prolification, and is the zone of election for all pathological processes. Also on account of its close relation to a joint, and exposed position, it is most liable to overstrain, local fatigue, and other slight traumatisms. Whence the explanation of the fact that the juxta-epiphyseal portion of long bones, and to some extent the corresponding part of other bones, is much the most frequent point of departure for inflammations and development of

neoplasms during the period of growth. Also at this period, that end of the bone which contributes most to its growth in length, is the seat of election for neoplasm and inflammatory lesions. Hence, the more frequent appearance of benign and malignant growths in the epiphyses at the shoulder, wrist and knee, than in those at the elbow, hip and ankle. So with all the inflammatory processes, tubercular, or other kind. Though, on account of certain joints being more exposed to traumatisms, the rule is not as invariable for inflammatory processes as for neoplasms.

BLOOD FORMATION AND CIRCULATION.

(*Semi-diagrammatic.*)

INDEX TO PLATE.

ARTERIES.

(1) Carotid Arteries, which, with the vertebral, supply the head.
(2) Innominate Artery.
(3) Subclavian.
(4) (4) (4) Arch of the Aorta — ascending, transverse and descending portion.
(5) (5) Pulmonary Arteries, right and left, containing venous blood.
(6) Thoracic Aorta.
(7) (8) (9) Gastric, Hepatic and Splenic — branches of the Cœliac Axis, which is a branch of
(10) Abdominal Aorta.
(11) Superior Mesenteric — to small intestines and part of large.
(12) Renal.

VEINS.

(13) Vena Cava Superior.
(14) (14) Innominate — right and left.
(15) Subclavian.
(16) Jugular.
(17) Pulmonary — containing arterial blood.
(18) Vena Cava Inferior.
(19) Hepatic.
(20) Gastric.
(21) Splenic.
(22) Mesenteric.
(23) Vena Portæ.
(24) Renal (emulgent).
(25) Right Auricle.
(26) Left Auricle.
(27) Right Ventricle.
(28) Left Ventricle.
(29) Thoracic Duct.

VISCERA AND LYMPHATICS.

(30) Stomach.
(31) Spleen.
(32) Liver.
(33) Kidney.
(34) Duodenum.
(35) Ascending Colon.
(36) Descending Colon.
(37) Lymphatics of the Intestines — the vessels being called Lacteals; the glands, the Mesenteric Glands.

THE CIRCULATION.

The *greater* or *Systemic Circulation* includes the course of the blood from the left auricle (26), through the left ventricle (28), arch of the aorta (4), the arteries to the upper extremities (3), those to the head (1), thoracic aorta (6) and its branches, abdominal aorta (10) with its branches, and its continuation and subdivisions for the lower extremities; together with the capillaries and veins corresponding to the areas of distribution of the arteries — the veins from the head and upper extremities joining to form the superior vena cava (13), which opens into the right auricle — those from the lower extremities and the pelvic and abdominal viscera join to form the inferior vena cava (18), which also opens into the right auricle.

The blood from the intestines and digestive organs passes through a second set of capillaries, in the liver, before joining the general current in the vena cava.

The *Portal Circulation* — a part of the Systemic — includes the course of the venous blood from all the organs of digestion, through the superior and inferior mesenteric veins and the splenic and gastric veins, which four trunks join to form the *portal* vein (23). This vein is about four inches long, and extends from behind the head of the pancreas to the transverse fissure of the liver, where it subdivides, and the blood, after passing through a second set of capillaries in the liver, leaves it through the *hepatic* veins, and empties into the vena cava inferior. The portal system of veins has no valves.

The *lesser* or *Pulmonic Circulation* includes the course of the blood from the right auricle (25) through the right ventricle (27), through the pulmonary arteries (5, 5), to the lungs, and its return through the pulmonary veins (17),

with a fresh supply of oxygen, to be again distributed throughout the system.

The Lymphatic System is an appendix of the Vascular System. Lymphatic vessels begin in the tissues as "lymph spaces" in connective tissue, as "perivascular spaces," and as blind tubules within the villi of mucous membrane. These spaces, or canals, unite to form tubes which unite again and converge to form the *thoracic duct* and the *right lymphatic duct*. In their course they pass through (rather empty into and begin anew) numerous lymphatic glands, which are a collection of lymph follicles, and are of the size of a pin head and larger. In structure these vessels resemble veins and have many valves. The functions of the lymphatic system are, to serve as nutrient channels in those tissues devoid of blood-vessels; as a drainage apparatus to collect and return to the blood fluids which have oozed through the capillaries to irrigate the tissues; and as absorbents and carriers of both waste products and food products. The lymphatics from the intestines are the *lacteals*, and during digestion, their contents are called *chyme*. The lymph current is from the periphery to the center only.

The *blood* is the medium of exchange between the outer world and the tissues of the body. It conveys tissue building materials from without — food products from the digestive tract, and oxygen from the lungs. The food products are in the form of solutions and emulsions, and are absorbed by the veins and lymphatics. Their evolution into blood and tissue pabulum is carried on while circulating in the vessels and passing through the various organs, as the spleen, liver, red marrow of bones, etc. The capillaries serve as the ultimate distributers of the renovated blood to the tissues, which assimi-

late the new and give up the old. From the intercellular and lymph spaces, this blood fluid, charged with waste products, is then taken up by the veins and lymphatics and passed to and through various excretory organs, as the lungs, skin, kidneys, liver, etc., which separate the effete materials to be cast off.

The blood makes a complete circuit of the body, on an average, in thirty-two or thirty-three seconds, or during twenty-seven heart-beats.

In the adult, the blood constitutes one-thirteenth part of the weight of the body; in the new-born infant, one-nineteenth.

Life is endangered by hemorrhage, in proportion to the amount and rapidity of the bleeding. In adults, when one-half the total blood is lost suddenly, death is liable to take place, and in newly born children, when a few ounces are lost. The old, the young, and the adipose bear the loss of blood badly.

NERVOUS SYSTEM.

SPINAL NERVES.

(A) *Cervical Plexus*, consisting of first four cervical nerves (1), (2), (3), (4).

(B) *Brachial Plexus*, consisting of (5) fifth cervical, (6) sixth cervical, (7) seventh cervical, (8) eighth cervical, and (9) first dorsal nerves.
(10) Second dorsal. (11) Third dorsal.

(C) *Lumbar Plexus*, consisting of (12) the first lumbar, (13) second lumbar, (14) third lumbar, (15) fourth lumbar, and the dorsi-lumbar cord.

(D) *Sacral Plexus*, consisting of (16) the fifth lumbar, (17) first sacral, (18) second sacral, (19) third sacral, and (20) part of fourth sacral.

(21) Fifth sacral. (22) Coccygeal.

(a) Phrenic — internal respiratory.

(b) Long thoracic — external respiratory.

(c) Spinal Cord.

(d) Brain.

(E) Method of communication of Spinal Nerves with Sympathetic, by a twig which is composed of white matter from the cord to the ganglion and gray matter from the ganglion to the cord.

CRANIAL NERVES.

(F) Olfactory.

(G) Optic.

(H) Motor Oculi.

(I) Patheticus.

(J) Tri-facial. (a) Ophthalmic division. (b) Superior maxillary division. (c) Inferior maxillary division. (e, h) Dental branches. (f) Branch to palate. (g) Lingual — special nerve of taste to tongue. (j) Supraorbital branch of ophthalmic division.

(K) Abducens.

(L) Portio dura — facial nerve — nerve of expression. (The Portio-mollis not shown.)

(M) Eighth nerve. (m) Glosso-Pharyngeal branch. (n) Pneumogastric branch. (p) Spinal Accessory branch.

(N) Hypoglossal nerve.

SYMPATHETIC SYSTEM.

(I) Cervical portion: (1) Superior, (2) Middle, (3) Inferior Cervical Ganglia.
(II) Thoracic portion.
(III) Lumbar portion.
(IV) Sacral portion.
(V) Ganglion impar.

The Cephalic portion consists of four pairs of ganglia, namely, the ophthalmic, the spheno-palatine, the optic and the submaxillary — all in connection with the fifth cranial nerve, but communicating freely with the other cranial nerves.

The Sympathetic System has a double chain of ganglia, placed on each side of the bodies of the vertebræ. In the thorax they lie in front of the heads of the ribs. The ganglia correspond mostly with the vertebræ, and the divisions of the latter into regions. Each has a branch of communication with the spinal nerves — and all with each other — composed of white and gray matter.

These ganglia are the *lateral* or vertebral. They give off branches which go, chiefly, to the thoracic, abdominal, and pelvic cavities, forming the *collateral* or pre-vertebral ganglia, or centers, named the cardiac, the solar, and the hypogastric plexuses. From these gangliated plexuses, branches are again given off to form the *terminal* ganglia, or plexuses, which surround and accompany all the arteries of the viscera.

The sympathetic has independent functions, due to its own gray matter, such as are found in the automatic ganglia of the heart, the mesenteric plexus of the intestines, and those for the uterus, ureters, and walls of blood-vessels.

The dependent functions of the sympathetic are those which inhibit, augment, or modify impulses from the cerebro-spinal centers.

THE SPINAL CORD.

The *spinal cord* is that part of the central nervous system contained in the spinal canal, extending from the foramen magnum to the junction of the first and second lumbar vertebræ. It is fifteen to eighteen inches in length, and has a cervical and a lumbar enlargement. A median fissure, before and behind, divides it into symmetrical halves connected by a commissure. The gray matter is in the center, in the form of two crescents, placed with their convexities together, giving an anterior and a posterior horn for each lateral half. Around the gray matter, the white conducting matter is disposed as tracts or columns, between or through which the anterior and posterior roots of the spinal nerves pass to or from the horns of the gray matter.

The spinal cord is, first, a conducting medium; second, a center, or centers, for reflex action; third, for automatic impulses. It conducts outgoing impulses as motor to muscles, vaso-motor to blood-vessels, secretory to glands, trophic to the tissues. The paths for the outgoing impulses are, chiefly, the motor tracts from the brain — the direct pyramidal in the anterior median part, and the crossed pyramidal in the posterior part of the lateral columns. Fibers from these tracts pass to and through the cells of the anterior horn of each segment to the anterior roots of the spinal nerve. Hence the motor tracts diminish in size from above downward. It also conducts in-going impulses, causing *general* sensations — cutaneous, articular,

muscular, visual; *special* sensations — tactile, pain, heat, exciting reflex and automatic centers. These in-going impulses come from the periphery — through the posterior roots of the spinal nerves, to and through the cells in the posterior horns of the gray matter, and thence upward through the *sensory tracts* — the posterior median and the posterior lateral columns. The sensory tracts increase in size from below upward. Impulses are also conducted, from one segment to another, through the " association tracts " — the anterio-lateral column — which are of uniform size throughout the cord.

A center for a spinal reflex is that part of the gray matter which transfers a stimulus from the in-going fiber of the posterior root to the out-going fibers of the anterior root, constituting the middle part of the reflex arc.

The spinal reflexes are the superficial or *cutaneous*, the deep or *tendon reflexes* and the *organic*. The cutaneous reflexes are the *plantar*, the *cremasteric*, the *gluteal*, the *abdominal*, the *epigastric* and the *interscapular*. The deep reflexes are the *knee-jerk*, the *jaw-jerk*, the *ankle clonus*, and the *abdominal reflex*. The organic reflexes are concerned in the acts of respiration, circulation, secretion, micturition, defecation, etc.

The automatic centers of the cord are those which retain their activity after being separated from the medulla, but, normally, are subject to the control of the higher centers of the medulla and cerebrum, and are subordinates to these. Examples are the cilio-spinal center for dilating the pupil (opposite the lower cervical and the upper two dorsal vertebræ); the ano-spinal center in the lower lumbar segments; the vesico-spinal about the fourth or fifth lumbar; the vaso-motor centers; the sweat centers.

A segment of the spinal cord is that portion of its entire thickness which corresponds to the origin of a pair of spinal nerves. There are, hence, thirty-one segments, each of which has its own special functions as a nerve center, and also functions for transmitting and modifying impulses from other segments and distant centers.

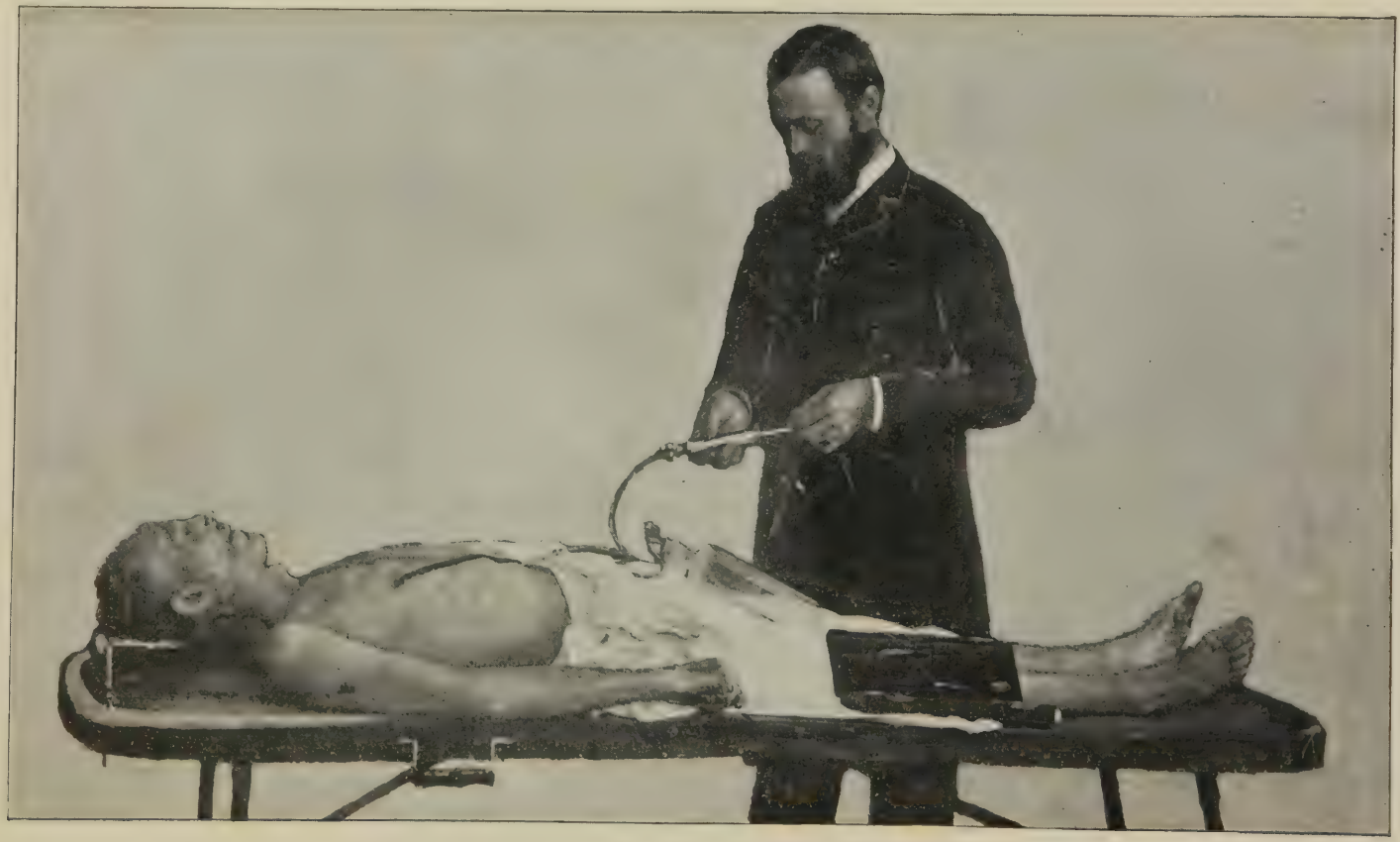
Each of the thirty-one pairs of spinal nerves has two roots of origin from the cord — a posterior, afferent or sensory root, with a ganglion of gray matter, and an anterior, efferent, or motor root. The two roots join at the intervertebral foramen, forming a compound nerve, which then separates into an anterior and a posterior division, or ventral and dorsal, each of which has special relations — the dorsal supplying the structures about the spinal column. They are smaller than the ventral, except those of the first and second — the sub-occipital and the great occipital — which supply the back part of the scalp.

The ventral divisions supply all the anterior parts of the body. Those for the limbs join and intermingle so as to form plexuses. The ventral plexus for the upper limb is derived from five spinal nerves, while the lumbo-sacral plexus for the lower limb is derived from nine.

As a general rule, a particular nerve trunk supplies those parts which are associated in function — as the muscles which move a joint (muscular branch), the joint itself (articular branch), the skin about the joint and insertion of the muscles (cutaneous branch).

The roots of the first cervical nerve pass slightly upward in the canal to reach the foramen of exit. Those of the second pass horizontally, while all others pass downward in the canal to reach the foramen of exit, the spinal canal being much larger than the cord.

The origins of the nerves in the spinal cord have the fol-



OPERATOR EXTRACTING WATER IN A CASE OF DROPSY.

(See page 124.)

lowing relations to the spinous processes of the vertebræ:

First cervical — level of foramen magnum.

Second cervical — a little below occipital bone.

Third cervical — middle of space between occipital bone and spinous process of axis.

Fourth cervical — spine of axis.

Fifth cervical — spine of third vertebra.

Sixth cervical — between third and fourth spines.

Seventh cervical — from spine of fourth to spine of fifth.

Eighth cervical — below spine of fifth vertebra.

First dorsal — spine of seventh cervical vertebra.

Second dorsal — seventh cervical to first dorsal vertebra.

Third dorsal — first dorsal vertebra and below.

Fourth dorsal nerve — second dorsal vertebra.

Fifth dorsal — third dorsal vertebra.

Sixth dorsal — fourth dorsal vertebra.

Seventh dorsal — fifth dorsal vertebra and above.

Eighth dorsal — from fifth to sixth dorsal vertebra.

Ninth dorsal — from sixth to seventh dorsal vertebra.

Tenth dorsal — from seventh to eighth dorsal vertebra.

Eleventh dorsal — from eighth to ninth dorsal vertebra.

Twelfth dorsal — from ninth to eleventh dorsal vertebra.

The *five lumbar* nerves arise from between spines of eleventh and twelfth dorsal vertebræ. The *five sacral* and the *coccygeal* arise from level of the spine of twelfth dorsal to first lumbar. The cord terminates at lower border of first lumbar vertebra.

Hence any lesion which paralyzes the neck and upper limbs must be above the fifth cervical vertebra. The phrenic nerve — a part of the third and fourth — is affected only when the lesion is at or above the axis. A lesion at the sixth or seventh cervical paralyzes all the intercostal muscles; at the third dorsal, all spaces below the third are

affected; at the fifth dorsal, the abdominal walls; at the eleventh dorsal, the lumbar and sacral plexuses become involved; at the twelfth dorsal, the sacral plexus is paralyzed.

(For the Brain, see description of the Head.)

THE BODY AND EXTREMITIES.

INDEXES TO SECTIONS.

MUSCLES OF THE ANTERIOR PART OF THE BODY.

(d) Isthmus of the Thyroid gland, covering the upper part of the Trachea.
(1) Clavicle.
(g) Manubrium of Sternum.
(h) Central part of Sternum (Gladiolus).
(i) Coracoid process of Scapula.
(k) Acromion process.
(l) First rib. (m) Second rib. (n) Third rib.
(o) Fourth rib. (p) Fifth rib.
(r) Head of Humerus (greater tuberosity).
(s) Interclavicular ligament.
(t) Rhomboid ligament.
(u) Aponeurosis of External Intercostals.
(v) Acromio-clavicular ligament.
(w) Coraco-acromial ligament.
(17) Platysma-Myoides — a cutaneous muscle, the upper end of which is one of the muscles of expression.
(18) Sterno-mastoid (sternal portion).
(19) Sterno-hyoid.
(20) Scalenus Anticus.
(21) Pectoralis Major.

(22) Pectoralis Minor.

(23) Subclavius.

(24) Serratus Magnus — interdigitating with (25) External Oblique of the abdomen.

(26) Linea Alba.

(27) Rectus. (28) Its transverse aponeuroses (Linea Transversæ).

(29) Pyramidalis.

(30) Internal Oblique.

(31) Poupart's Ligament, or Crural Arch, composed of the thickened lower border of the aponeurosis of external oblique. Below it, is the Saphenous opening — the outer end of the Femoral canal, through which comes Femoral Hernia.

(32) External boundary (Pillar) and (33) internal boundary (Pillar) of (34) external abdominal ring, which is an opening in the aponeurosis of external oblique, caused by divergence of its fibers. The lower boundary of the ring is the crest of the Pubes.

(35) Internal abdominal ring, the opening in transversalis fascia, situated a half-inch above Poupart's ligament, and midway between spines of the Pubes and Ilium.

(36) Inguinal canal for the spermatic cord, and through which oblique inguinal hernia makes its way. Its roof is the conjoined lower border of internal oblique and transversalis muscles; its floor, Poupart's ligament; its outer wall, the aponeurosis of external oblique; its inner wall, the transversalis fascia, upon which the number 36 is placed.

(37) Border of Deltoid muscle.

(38) Coraco-Brachialis.

(39) Short head, and (40) long head, of biceps.

THE THORAX.

(5) Clavicle.

(6) Sternum. (6) Manubrium. (6′) Gladiolus. (6″) Ensiform Cartilage.

(7) Ribs.

(8) Costal Cartilages—those of the false ribs—eighth, ninth and tenth—join that of the seventh.

(9) Sterno-Clavicular joint with ligaments, and (9′) without.

(10) Costo-Sternal joint with ligament.

(11) Inter-clavicular notch.

(12) Internal and (12′) External Intercostal muscles—the analogues of the oblique muscles of the abdomen. The external are aponeurotic from the sternum to the ends of the costal cartilages, and both are aponeurotic from the angles of ribs to spine. Between these two muscular planes, in an osteo-fibrous canal on the under border of each rib, are the intercostal muscles and nerves.

(13) (13′) Costal (Parietal) Pleuræ.

MEDIASTINUM AND LUNGS.

(14) Mediastinum—the space from before backward, from sternum to spine, bounded laterally by the Pleuræ. Nothing but the cellulo-adipose tissue is shown. The space is divided into the *anterior* (from the sternum to pericardium), which contains the remains of the Thymus gland, Triangularis Sterni muscle, left Brachio-Cephalic vein (crossing behind first part of sternum), Lymphatic glands

and left internal Mammary artery and vein; the *middle*, which contains the heart with its large vessels and Phrenic nerves; and the *posterior*, containing the Œsophagus, Pneumogastric nerves, Aorta, Thoracic Duct, Azygos vein, Trachea and Lymphatic glands.

(15) (15) Upper and lower lobes of left lung.

(16) (16) (16) Upper, middle and lower lobes of right lung.

INTERIOR OF LUNGS.

(17) Trachea.

(A) Arch of Aorta.

(B) Pulmonary artery, which begins in front of root of aorta and bifurcates under its arch, giving a branch to each lung. It conveys venous blood from the right ventricle to the lungs.

(C) Superior Vena Cava, emptying into right auricle.

(D) One of Left Pulmonary veins, there being two on each side which convey the purified blood from the lungs to the left auricle, by four openings.

THE HEART.

(a) Right Auricle.

(b) Right Auricular appendage.

(c) Left Auricle.

(d) Left Auricular appendage.

(e) Mitral (Left Auriculo-Ventricular) valve.

(f) Tricuspid (Right Auriculo-Ventricular) valve.

(g) Musculi Papillares, with the free ends of which the flaps of the valves are connected by (h) the Chordæ Tendinæ.

(i) Ventricular Septum.

ABDOMEN AND ABDOMINAL VISCERA.

(14) Loop of large intestine (Sigmoid Flexure of Colon).

(15) Bladder.

(16, to the left.) Great Omentum with Omental vessels, branches of the Gastric.

(16, to the right.) Transversalis fascia and subperitoneal fat, in which are imbedded (C') the deep epigastric vessels — the artery, a branch of the external iliac, passing upward and inward to reach the sheath of the rectus muscle, in which it passes upward to anastomose with the superior epigastric, the terminal branch of the internal mammary. In obstruction of the abdominal or thoracic aorta, collateral circulation is carried on largely by this circuit. The veins (the inner one the larger) passing down, join the external iliac.

(17) Fold of Peritoneum — Median Vesical ligament. (a2) Parietal Peritoneum.

(X) Spermatic artery and vein.

THE LIVER.

(1) Right lobe — lower surface.

(2) Left lobe.

(3) Gall-bladder distended, which normally projects from under the ninth costal cartilage. When distended, and the liver is enlarged, it approaches the umbilicus.

(4) Portal vein subdividing.

(5) Hepatic veins uniting to join the vena cava as it lies in its groove on posterior border of liver.

(6) Common bile duct, between which and the Portal vein, is the Hepatic artery — a branch of the Cœliac axis.

(7) Hepatic duct, joining (8) the Cystic duct, to make the common duct.
(9) Neck of gall-bladder.
(10) Cystic artery.
(11) The Round ligament — the remains of the umbilical artery, lying in the longitudinal fissure between the double fold of peritoneum (12), called the Falciform or Suspensory ligament.

STOMACH AND INTESTINES.

(1′) Œsophageal opening of stomach.
(3) Cardiac end of stomach and interior wall.
(3′) Rugæ of mucous membrane.
(4) Pylorus.
(5) Beginning of Duodenum.
(7) Jejunum and Ileum.
(8) Vermiform Appendix.
(9) Cæcum (Caput Coli).
(10) Ascending Colon.
(11) Hepatic Flexure.
(12) Transverse Colon.
(13) Splenic Flexure.
(14) Descending Colon, terminating in the Sigmoid Flexure.
(15) Bladder distended.

SECTION OF BODY, AND SHOULDER AND HIP JOINTS.

(1) Superior Constrictor muscle of Pharynx.
(2) Middle.
(3) Inferior.
(4) Mucous membrane of Pharynx.
(5) Clavicle.
(6) Acromio-Clavicular ligament.

(7) Ribs.
(8) Acromion process of Scapula.
(9) Coraco-acromial ligament.
(10) Tendon of long head of Biceps.
(11) Capsular ligament.
(12) Anterior or inner surface of external Intercostal muscles.
(12′) Internal surface of internal Intercostals.
(13) Scapula.
(14) Head of Humerus, the lesser tuberosity of which looks directly forward.
(15′) Surgical neck of Humerus, which extends from tuberosities to lower border of axilla.
(16) Coracoid process of Scapula.
(17) Articular Cartilages of head of Humerus and Glenoid Fossa.
(18) Spleen.
(19) Pancreas.
(20) Right kidney.
(20′) Pyramidal substance of kidney.
(21) Supra-renal Capsule.
(22) Pelvis.
(22′) Calyces.
(23) Cortical substance.
(24) Ureter.
(25) Transversalis muscle.
(26) Psoas.
(27) Iliacus Internus.
(28) Pyriformis, the anterior border being continuous with the Coccygeus, forming the floor of the Pelvis.
(29) Sacrum.
(30) Sacro-Iliac ligament.

(31) Capsular ligament of hip joint. It is re-enforced, on the anterior surface, by (32) the inverted "Y" or Ilio-Femoral ligament, which arises from the anterior-inferior spine of Ilium, and is inserted into (33) the intertrochanteric line of Femur.

(34) Outer surface Great Trochanter.

(35) Tuberosity of Ischium.

(36) Anterior pubic ligament.

(37) Obturator membrane.

(38) Pectineal eminence.

(39) Crest of Ilium, ending below in the anterior superior spine.

(40) Section of rim of Acetabulum, and articular cartilage.

(41) Synovial sac of hip joint.

(42) Lesser Trochanter.

(A) Aorta.

(E) Inferior Vena Cava.

(F) Right and left common Iliac arteries.

(F') Internal Iliac.

(F'') External Iliac.

(G) Left common Iliac vein.

(G') Left external Iliac vein.

(H) Common Femoral artery.

(H') Superficial Femoral.

(H'') Deep Femoral.

(1) Right Azygos vein, which takes the place of the vena cava within the chest, receiving all the right intercostal veins, and, after arching over the right bronchus, empties into the superior vena cava. It communicates with the inferior cava at its beginning, either directly or indirectly. It is joined by the left azygos about the middle of the chest.

(k) Subclavian artery, terminating at the lower border of the first rib, in the axillary, which terminates in (1) the brachial, at the lower border of the teres major muscle.
(m) Acrominal Thoracic.
(n, n′) Short and Long Thoracic.
(o) Subscapular — giving off dorsalis scapulæ.
(p) Anterior and (q) Posterior Circumflex.
(r) Superior Profunda.
(s) Branches of Transversalis Colli.
(t) Intercostal arteries and veins.
(u) Splenic artery.
(v) Renal artery.
(v′) Lumbar artery.
(w) Renal vein.
(x) Spermatic artery and vein.
(y) Inferior Mesenteric.
(a′) Lumbar artery and vein.
(b′) Superior Gluteal.
(b2) Ilio-lumbar.
(c′) Deep Epigastric.
(d′) Circumflex Iliac.
(e′) Sciatic and Internal Pudic.
(f′) External Circumflex.
(g′) Obturator.

UPPER EXTREMITY.

PLATE 1.

Arm. — (1) Acromion process. (12) Fascia of pectoralis muscle. (13) Deep fascia of arm. (18) Deltoid muscle covered with fascia. (19) Pectoralis major muscle. No arteries except small muscular (B) or cutaneous branches are shown. (I) Subcutaneous veins. (II) Basilic vein.

(III) Cephalic vein. (IV) Median and median cephalic veins. (a) Supraclavicular nerve. (b) Posterior cutaneous, from the circumflex. (c) Branches from the anterior thoracic. (d) Internal cutaneous. (e) Lesser internal cutaneous. (h) Musculo-cutaneous.

Fore-arm and Hand. — (9) Deep fascia. (10) Bicipital fascia. (11) Palmar fascia. (11′) Transverse palmar ligament. (12) Anterior annular ligament. (14) Panniculus adiposus of the fingers. (29) Palmaris brevis muscle. (III) Cephalic or radial vein. (IV) Median vein. (V) Median Basilic vein. (a) Branches of internal cutaneous nerve. (b) Same. (c) Branches of musculo-cutaneous nerve. (i) Palmar branch of ulnar nerve. (m) External cutaneous branch from musculo-spinal nerve.

PLATE 2.

Arm. — (1) Acromial end of clavicle. (2) Coracoid process of scapula. (3) Greater tuberosity of head of humerus. (4) Lesser. (5) Bicipital groove. (8) Coraco-clavicular ligament. (9) Coraco-acromial ligament. (10) Capsular ligament. (15) Bicipital fascia. (16) Pectoralis major tendon. (17) Triceps muscle. (19) Pectoralis major. (20) Biceps. (20′) Short head of biceps. (20″) Long head of biceps. (21) Coraco-brachialis muscle. (22) Brachialis anticus muscle. (23) Triceps muscle. (A) Brachial artery. (D) Inferior profunda. (III) Cephalic vein. (IV) Median Cephalic. (V) Venæ comites — brachial. (VI) Beginning of Cephalic.

Fore-arm and Hand. — (1) Internal condyle of humerus. (9) Deep fascia. (10) Aponeurosis of biceps muscle. (11) Palmar fascia. (12) Anterior annular ligament. (13) Sheaths of flexor tendons — circular and oblique fibers. (15) Biceps muscle. (15) Inferior bicipital tendon. (16)

Brachialis anticus muscle. (17) Triceps. (18) Supinator longus. (22) Flexor carpi radialis. (23) Palmaris longus. (24) Flexor sublimis digitorum. (27) Flexor carpi ulnaris. (28) Pronator quadratus. (29) Palmaris brevis. (30) Abductor pollicis. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (36) Lumbricales. (B) Radial artery. (G) Ulnar artery, forming the superficial palmar arch. (K) Digital branches. (N) Superficial radial nerve. (N″) Dorsal branch.

PLATE 3.

Arm. — (1) Acromio-clavicular joint. (2) Coracoid process. (3) Greater tuberosity of head of humerus. (4) Lesser. (11) Sheath of biceps tendon. (16) Insertion of pectoralis major muscle. (17) Insertion of deltoid. (18) Deltoid. (20′) Long head of biceps. (20″) Short head. (21) Coraco-brachialis. (22) Brachialis anticus. (23) Triceps. (A) Brachial artery. (B) Muscular branches. (C) Superior profunda. (D) Inferior profunda. (d) Internal cutaneous nerve. (f) Median nerve. (g) Ulnar. (h) Musculo-cutaneous.

Fore-arm and Hand. — (1) Internal condyle. (2) Radius. (3) Ulnar. (4) Pisiform bone. (5) Unciform bone. (6) First phalanges. (7) Second. (8) Third phalanges. (15) Biceps tendon. (16) Brachialis anticus. (19) Extensor carpi radialis brevior. (20) Supinator brevis. (24) Flexor sublimis digitorum. (26) Flexor longus pollicis. (28) Pronator quadratus. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (37) Interossei. (A) Brachial artery. (B) Radial. (C) Superficial volar branch. (D) Dorsal branch. (E) Ulnar

artery. (F) Interosseous. (G) Superficial branch for superficial palmar arch. (K) Digital branches. (V) Venæ comites. (d) Median nerve. (d') Muscular branch. (e) Internal interosseous. (g) Digital branches. (k) Ulnar nerve. (k, k') Digital and muscular branches. (l) Radial nerve. (n) Superficial radial. (n') Anterior. (n'') Posterior branches.

PLATE 4.

Arm.—(2) Acromion process. (2') Coracoid process. (3) Clavicle. (4) Greater tuberosity. (11) Capsular ligament. (12) Sheath of biceps tendon. (20) Long head of biceps. (24) Internal head of triceps muscle. (24'') External head of triceps. (24''') Middle or scapular head of triceps. (A) Axillary artery. (B) Brachial artery. (C') Acromial branch of transverse scapular artery. (D) Thoracic branch of brachial artery. (E) Acromial thoracic. (F) Long thoracic branch. (G, G') Subscapular artery and branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda.

Fore-arm and Hand.—(16) Anterior ligament, elbow joint. (18) External lateral ligament. (18') Part of orbicular ligament. (20) Interosseous ligament. (5) Styloid process of ulna. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Trapezium. (11) Carpo-metacarpal joint of thumb. (12) Metacarpal. (13) First phalanges. (14) Second phalanges. (15) Third phalanges. (16, 18, 18') Ligaments of elbow joint. (31) Pronator radii teres. (32) Supinator brevis muscle. (33) Flexor carpi radialis. (34) Pulmonis longus. (35) Flexor sublimis digitorum. (36) Flexor profundis digitorum. (37) Flexor longus pollicis. (38)

Pronator quadratus. (39) Adductor pollicis. (40) Abductor minimi digiti. (41) Palmar interosseous. (B) Radial artery. (D) Dorsalis pollicis. (G) Ulnar. (G′) Ulnar recurrent. (H) Interosseous. (I) Metacarpal branch. (K) Termination of ulnar, which is continued as the superficial palmar arch.

PLATE 5.

Arm.— (2) Acromion. (3) Clavicle. (22) Coracoid process. (4) Greater tuberosity of the head of humerus. (12) Sheath of biceps tendon. (19) Insertion of pectoralis major. (20) Biceps tendon, long head. (21) Short head. (22) Coraco-brachialis. (23) Brachialis anticus. (24) Triceps muscle. (A) Axillary artery. (B) Brachial. (F) Long thoracic. (G, G) Subscapular and its branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda. (N) Anastomotica magna.

Fore-arm and Hand.— (2) External condyle of humerus. (4) Ulna. (6) Radius. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform. (10) Trapezium. (11) Trapezoid. (12) Metacarpal. (13, 14) Phalanges of thumb. (16) Anterior ligaments. (20) Interosseous ligaments of elbow joint. (22, 23, 24) Ligaments of wrist joint. (30) Tendon of biceps — insertion. (31) Pronator radii teres. (32) Supinator brevis. (36′) Tendons of flexor sublimis digitorum. (38) Pronator quadratus. (41) Interosseous. (A) Brachial artery, lower end. (B) Radial artery. (C) Superficialis volæ. (D) Dorsal branch of radial. (D′, D″) Dorsal branches to thumb. (E) First digital branch. (E′, E″) Branches to ulnar and radial sides of thumb (princeps pollicis). (F) Deep palmar branch. (G) Ulnar artery. (G′) Ulnar recurrent interos-

seous. (H′) Anterior interosseous. (I) Dorsal branch. (K) Ulnar, dividing into deep and superficial branches; the superficial joining (C) to form (K) the superficial palmar arch — the deep branch joining from the radial to form (L′) the deep palmar arch. (M) Digital branch to little finger. (N) Common digital branches. (O) Interosseous arteries. (P) Digital.

PLATE 6.

Arm.— (2) Coracoid process. (3) Clavicle. (4) Greater tuberosity of humerus. (9) Coraco-clavicular ligament. (10) Coraco-acromial. (11) Capsular ligament. (12) Sheath of biceps tendon. (16) Anterior ligament of elbow joint. (17, 18) Lateral ligaments. (20) Long tendon of biceps. (18′) Orbicular ligament. (A) Position of axillary artery. (D′) Long thoracic. (E) Anterior thoracic. (F) Subscapular. (G) Internal cutaneous of arm (G′) Posterior branch. (H) Middle cutaneous. (H′) Ulnar cutaneous branch. (I) Musculo-cutaneous nerve. (K) Circumflex. (L) Posterior cutaneous of arm. (M) Median nerve. (N) Ulnar nerve. (O) Muscular spiral. (O′) External cutaneous branch.

Fore-arm and Hand.— (1) Internal condyle of humerus. (2) External. (3) Internal part of trochlear surface of humerus. (4) Ulna. (5) Styloid process. (6) Radius. (6′) Neck of radius. (6″) Bicipital tuberosity. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Scaphoid. (11) Trapezium. (12) Metacarpus. (13, 14, 15) Phalanges. (19) Oblique ligament. (20) Interosseous membrane. (21, 24) Straight and oblique volar ligaments. (22, 23) Lateral ligaments. (25, 26) Anterior carpal ligaments. (27, 28, 29, 30) Carpal, metacarpal and transverse ligaments. (a) Lesser

internal cutaneous nerve. (b′) Palmar branch. (b″) Ulnar cutaneous branches. (c) Musculo cutaneous. (d) Median nerve. (d′) Muscular branches. (e) Interosseous branch. (f) Long palmar. (g) Digital branches. (h) Ulnar nerve. (i) Dorsal branch. (k) Palmar branch. (k′) Superficial palmar branch. (k″) Digital branches. (k‴) Deep ulnar branch. (l) Radial. (l′) External cutaneous branch. (m) Posterior branch. (n) Anterior. (n′) Dorsal branch of thumb.

LOWER EXTREMITY.

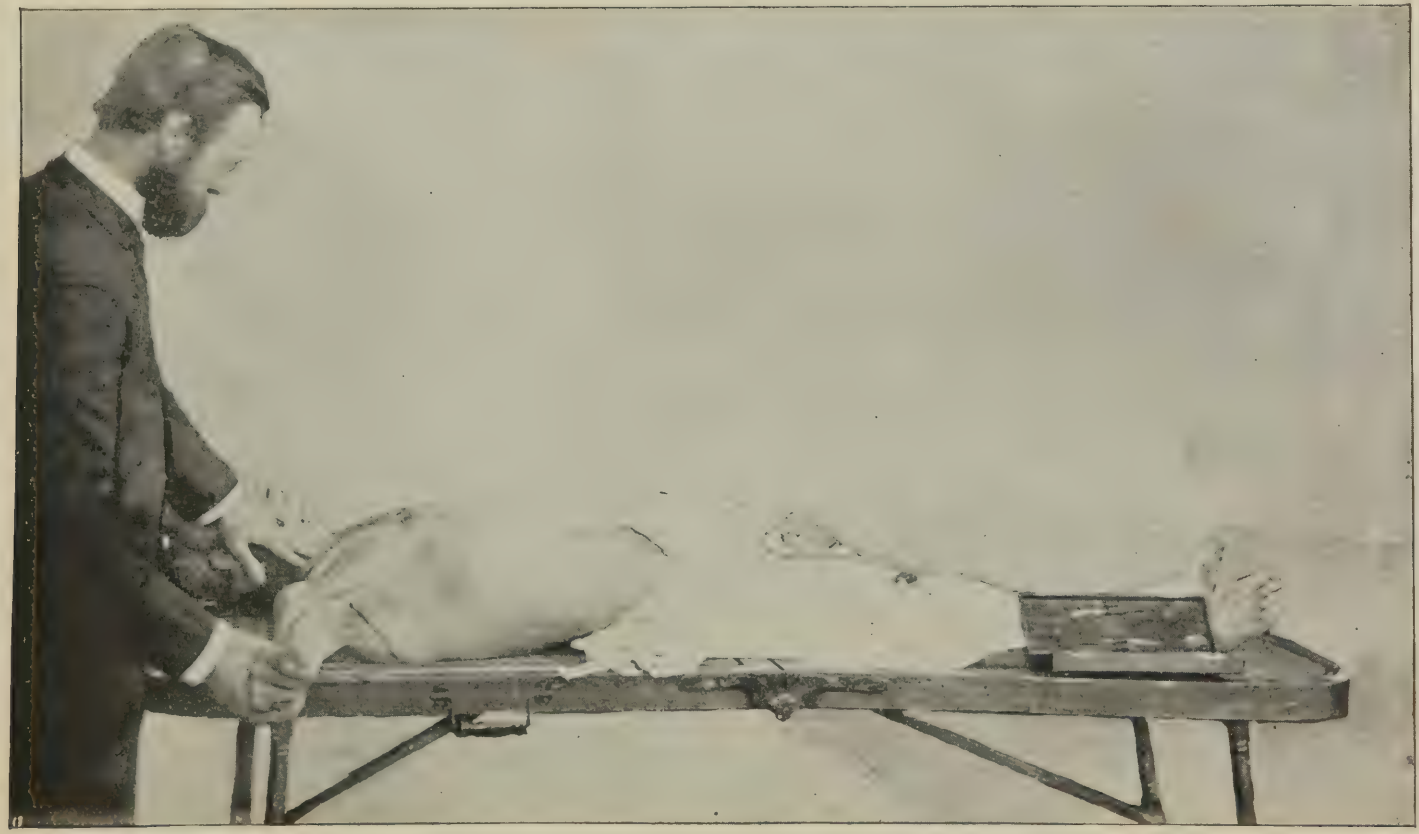
PLATE 1.

Thigh.— (1) Patella. (5) Fascia lata. (6) Crural fascia. (8) Bursa patellæ. (I) Internal saphenous vein. (II) Subcutaneous veins. (a) External cutaneous nerve. (b) Branch of genito-crural nerve. (c) Branch of inguinal. (e) Internal cutaneous nerve. (f) Middle cutaneous.

Leg.— (2) Internal malleolus. (4) External malleolus. (6) Deep fascia of the leg. (7) Anterior annular ligament. (8) Dorsal fascia of the foot. (I) Subcutaneous veins. (II) Long saphenous vein. (a) Long saphenous nerve. (b) Musculo-cutaneous. (c) Cutaneous branches of external popliteal. (d) Internal cutaneous of the dorsum of foot. (e) Middle cutaneous of dorsum. (g) Digital nerves.

PLATE 2.

Thigh.— (1) Patella. (2) Internal condyle of femur, (3) of tibia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (14) Pectineus muscle. (15) Adductor longus. (17) Gracilis. (I) Long saphenous vein. (II) Subcutaneous veins. (e) Branches of internal cutaneous nerve.



OPERATOR DRAWING BLOOD FROM THE JUGULAR VEIN—THE NEEDLE INTRODUCED IN THE AXILLA AND IN POSITION.

(See page 98.)

Leg.— (1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Metatarsal. (7) Anterior annular ligament. (9) Tibialis anticus. (10) Extensor digitorum longus. (10′) Peroneus tertius. (11) Extensor brevis digitorum. (14) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (A) Anterior tibial artery. (A′) Dorsalis pedis artery. (III) Deep veins of leg.

PLATE 3.

Thigh.— (1) Patella. (2) Internal condyle of femur. (3) Of tibia. (5) Deep fascia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (13) Psoas and internal iliac muscles. (14) Pectineus. (15) Adductor longus. (16) Adductor magnus. (17) Gracilis. (A) Femoral artery. (B) Deep femoral. (C) Muscular branches. (I) Internal saphenous vein. (c) Branch of ilio-inguinal nerve. (e) Branches of internal cutaneous. (f) Middle cutaneous. (g) Saphenous branches. (h) Muscular branches of crural nerve. (i) Musculo-cutaneous branches of crural nerve.

Leg.— (1) Tibia. (2) Internal malleolus. (4) Externa malleolus. (5) Metatarsal bones. (6) Fascia. (7) Anterior annular ligament. (9) Tibialis anticus tendon. (10) Extensor longus digitorum. (11) Extensor brevis digitorum. (12) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (b) Musculo-cutaneous nerves. (d) Dorsal cutaneous of foot. (e) Middle dorsal cutaneous. (f) Terminal branch of external saphenous. (g) Digital branches. (h) An-

terior tibial. (h') Internal. (h'') Internal branches of same.

PLATE 4.

Thigh.— (1) Femur. (2) Internal Condyle. (3) External Condyle. (4) Patella. (13) Gracilis muscle. (14) Adductor longus muscle. (15) Adductor brevis. (16) Adductor magnus. (17) Insertion of pectineus muscle. (A) Femoral artery. (B) Deep femoral. (D')First perforating artery. (F) Muscular branches. (5) Tuberosity of tibia. (7) Ligamentum patellæ (middle part). (8) Internal lateral part. (9) Internal lateral ligament. (10) External lateral ligament (anterior part). (10') Posterior part. (11) Synovial capsule.

Leg and Foot.— (1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (9) Anterior annular ligament. (10) Interosseous membrane. (10') Tibio-fibular ligament. (10'') Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (13) External lateral ligament (anterior part). (14) Transverse metatarsal ligaments. (15) Capsular and lateral ligaments. (16) Peroneus longus and brevis muscles. (17) Tendons of extensor longus digitorum muscle, (18) of extensor longus pollicis, (19) of tibialis anticus. (20) Dorsal interosseous muscle. (A) Anterior tibial. (A') Dorsalis pedis.

PLATE 5.

Thigh.— (1) Femur. (2) Internal condyle. (3) External condyle. (4) Patella. (7) Ligamentum patellæ. (8) Lateral ligament of patella. (9) Internal lateral ligament of knee joint. (10) External lateral ligament (anterior part). (10') Posterior part. (11) Synovial capsule. (16) Adductor magnus. (17) Insertion of pecti-

neus muscle. (A) Femoral artery. (B) Profunda femoris. (C) Descending branch of external circumflex artery. (D′) First perforating. (D″) Second perforating. (D‴) Third perforating. (E) Nutrient artery of femur. (F) Muscular branches. (G) Anastomotica magna. (H) Popliteal. (I) Muscular branches. (K) Superior external auricular. (L) Superior internal auricular. (M) Middle articular. (N) Sural branches. (O) Inferior external articular. (P) Inferior internal articular branches. (Q) Anterior tibial.

Leg and Foot.—(1) Tibia. (2) Internal. (3) External malleolus. (4) Fibula. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (10) Interosseous membrane. (10′) Tibio-fibular ligament. (10″) Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (12) Astragalo-scaphoid. (13) Anterior external lateral. (13′) Middle external lateral. (14) Transverse metatarsal. (15) Capsular ligaments. (A) Anterior tibial artery. (A′) Dorsalis pedis. (B) Recurrent tibial. (C) External malleolar. (C′) Internal. (D) External tarsal. (D′) Internal tarsal. (D″) Anterior tarsal. (E) Metatarsal. (F) Dorsal interosseous. (F′) Dorsalis hallucis. (F″) Deep plantar branch of same. (G) Posterior tibial. (H) Peroneal. (H′) Anterior peroneal. (K) Posterior internal malleolar. (K′) Posterior external. (L) Internal plantar. (L′) Internal superficial branch. (M) External plantar. (N) Superior plantar arch. (O) Sural branch.

PLATE 6.

Thigh.—(1) Femur. (2, 3) Internal and external condyles. (4) Patella. (5′) Tuberosity of tibia. (6) Head of fibula. (7) Ligamentum patellæ. (8) Internal lateral

part. (9) Internal lateral ligament of knee. (10, 10′) External lateral ligament. (11) Synovial capsule. (a) Anterior obturator nerve. (b) Internal cutaneous. (c) Anterior internal cutaneous. (d) Long saphenous. (e) Great sciatic. (f) External popliteal or peroneal. (f′) Posterior cutaneous branches of leg. (i) Internal popliteal nerve. (k) Sural or long cutaneous nerve. (l) Anterior external cutaneous.

Leg and Foot.—(Figures refer to same as in preceding plate). — (a) Long saphenous nerve. (b) Musculo cutaneous or superficial peroneal. (c) Anterior cutaneous branches. (d) Internal cutaneous branch of foot. (e) Middle cutaneous branch. (f) Posterior external cutaneous of leg. (g) Digital branches. (h) Anterior tibial. (h′) Internal branch. (h″) External branch. (i) Posterior tibial. (k) External saphenous branch. (k′) External cutaneous branch. (l) Internal plantar. (m) External plantar. (n) Digital plantar.

THE HEAD.

THE SKULL, SCALP, ETC.

The skull, the bony part of the head, consists of the cranium and the face. Eight bones compose the former, and fourteen the latter. The immovable joints of the skull are called sutures (5), of which those of the vertex are the most important. These sutures are best named anatomically, as the fronto-parietal (*coronal*), the inter-parietal (*sagittal*), occipito-parietal (*lambdoid*). The average thickness of the flat bones of the cranium is one-fifth of an inch. The thickest parts are the occipital protuberance and at the parietal and frontal eminences. The temporal region is the thinnest. These flat bones have some peculiarities. The outer layer of "compact tissue" (external table) is thick and tough; the inner (internal table), thin and brittle. The cancellous tissue (*diploë*), most marked in middle life, is "intermediate like a soft leather cushion," and is channeled for numerous large veins with thin walls. The frontal, and part of the temporal groups of the diploic veins, discharge into the external veins of the head, while the occipital, and part of the temporal, discharge into the sinuses of the *dura-mater;* thus affording collateral relief for obstructed circulation of the brain by the intercommunication of the internal and external venous systems. This relation explains the serious brain symptoms which are liable to follow even a slight septic inflammation of the scalp and lesions of the cranial bones. Great vascularity characterizes the bones of the cranium and face, as well as all

the soft parts connected with them; hence the relatively quicker and more certain repair of injuries, or wounds.

There are three kinds of sinuses: Those of the dura mater for the return of the venous blood from the brain; the cerebral sinuses, which are interspaces between its lateral halves or other parts; and those in the bone, as the frontal, sphenoidal, etc., which contain air and communicate with the air passages.

There are five distinct strata of tissues covering the cranium; 1. The skin. 2. Dense fibro-adipose tissue, in which are the hair bulbs and the cutaneous vessels and nerves. The arteries, adhering to and firmly embedded in this tissue, when cut, do not contract or retract, and are with difficulty seized and drawn out with forceps; hence the free hemorrhage in scalp wounds and the trouble in arresting it. 3. The occipito-frontalis muscle, with its aponeurosis, which gives power to move the scalp, and which is, like the facial muscles, supplied by the facial nerve, and is classed as one of the muscles of expression. These three structures constitute the *scalp*, as the term is commonly used. 4. Loose areolar tissue, without fat, which allows "scalp" to glide freely on 5. The pericranium (external periosteum).

The remarkable vitality of the flaps in extensive wounds of the scalp is due not more to the free arterial supply and anastomosis than to the fact that the arteries are carried with the flap entering it from its base.

Cephalæmatoma is a blood tumor between the pericranium and the bone, and is limited to one bone. The ordinary effusion of blood (hæmatoma), as from a bruise, is in the loose areolar tissue between the aponeurosis and the pericranium. It is liable to be diffuse, but is not often large, because the vessels in this tissue are small. Wounds

of the scalp are not more prone to erysipelatous inflammation than other wounds. But phlegmonous inflammation (erroneously called erysipelas) does often occur if the wound is not properly treated. The loose areolar tissue is a favorable nidus for sepsis. The skin heals rapidly and confines septic secretions beneath, which diffuse rapidly. Drainage, keeping the angles of the wound open, and compression are most important in scalp wounds.

(1) Frontal bone
(2) Parietal.
(3) Occipital.
(4) Squamous portion of Temporal.
(5, 5) Fronto-parietal (Coronal) and Occipito-parietal (Lambdoid) sutures
(6) Malar.
(7) External Auditory Meatus.
(8) Orbicularis Palpebrarum muscle.
(9, 9) Zygomatici Major and Minor.
(10) Masseter muscle.
(11) Orbicularis Oris.
(12) Levator Menti.
(13) Sterno-mastoid.
(14) Levator Anguli Scapulæ.
(15) Omo-hyoid — anterior part
(16) Internal Jugular vein.
(17) Facial vein.
(18) Temporal vein.
(19) Common Carotid artery.
(20) Facial artery.
(21) Superficial Cervical nerves.
(22) Facial nerve.
(23) Supra-maxillary division.

(24) Trachea.
(25) Scalp.
(26) Skull.
(27) Cerebrum.
(28) Cerebellum.
(29) Spinal cord.
(30) Medulla Oblongata.
(31) Eyeball.
(32) Internal Rectus muscle.
(33) Optic nerve.
(34) Internal surface of Malar bone.
(35) Inferior Maxillary.
(36) Anterior Naris.
(37) Inferior Dental artery, and
(38) Nerve.
(39, 40) Cortex of Cerebrum, showing convolutions of gray matter.
(41) Corpus Callosum.
(42) Corpus Striatum.
(43) Optic Thalamus.
(44) Section of Cerebellum.
(45) Medulla Oblongata.
(46, 47) Outer wall of nasal cavity, showing the three turbinated bones and the meatuses — superior, middle and inferior — and the distribution of the olfactory nerve,
(48) The Hard palate — formed in front by the superior maxillary, and behind by the palate.
(49) Pharyngeal opening of Eustachian tube.
(50) Pharynx.
(51) Soft palate.

(52) Lateral portion of roof of mouth.
(53) Tongue.
(54) Sublingual gland.
(55) Epiglottis.
(56) Larynx.
(57) Junction of pharynx and œsophagus. This point is opposite the body of the fifth cervical vertebra (its lower border) and corresponds with junction of larynx and trachea.
(58) Body of fifth cervical vertebra.
(58′) Spinal process of vertebra.

THE BRAIN.

The gray matter of the brain is disposed as a layer on the outer surface — the cortex with its convolutions; as circumscribed convolutions in the basal ganglia — corpus striatum, optic thalamus, corpora quadrigemina; or, as the central gray tube continued up from the spinal chord through the medulla and pons around the iter to the tuber cinereum. The white matter connects these parts in various ways — either longitudinally or transversely — the corona radiata (1), (2), (3), (4), connecting the cortex with the basal ganglia; the commissural fibers (c, c) connecting corresponding parts of the two hemispheres; the association fibers (a, a) connecting different areas of the same part; the longitudinal bundle of fibers, as pyramids, tracts, etc., connecting the gray matter of the spinal cord with all the brain centers.

The ventricles of the brain are the spaces between the different ganglia or parts.

DIAGRAM OF THE RELATIONS OF THE CENTRAL GANGLIA OF GRAY MATTER TO EACH OTHER AND TO THE SPINAL CORD.

(C, C) Cortical gray matter of the cerebrum.
(C, S) Corpus striatum.
(N, L) Lenticular nucleus — the extra-ventricular part of former.
(T, o) Optic thalamus.
(V) Corpora quadrigemina.
(P) Peduncle of cerebrum.
(H) Tegmentum — the upper part of the peduncle.
(P) Crusta — under part of peduncle.
(1, 1) Corona radiata of corpus striatum.
(2, 2) Corona radiata of lenticular nucleus.
(3, 3) Corona radiata of the optic thalamus.
(4, 4) Corona radiata of the corpora quadrigemina.
(5) Direct fibers to cortex.
(6, 6) Fibers from corpora quadrigemina to tegmentum.
(7) Fibers of the optic thalamus.
(m) Same fibers continued.
(8, 8) Fibers from corpus striatum and nucleus to crusta.
(M) Same continued in cord.
(S, S) Course of sensory fibers.
(a, a) Association system of fibers.
(c, c) Commissural fibers.
(R) Transverse section of spinal cord.
(v, W) Anterior root.
(h, W) Posterior root.

LEFT SIDE OF THE BRAIN, SHOWING THE FISSURES, CONVOLUTIONS AND MOTOR AREAS, AND THEIR RELATION TO THE SKULL BONES AND THEIR SUTURES.

The outer surface of the cerebral hemispheres is divided into four lobes by the fissure of Sylvius, the fissure of Rolando, and the parieto-occipital fissure. These, from their depth, regularity, and early development, are called primary fissures. The frontal lobe is that part anterior to the fissure of Rolando. The parietal lobe is between the fissure of Rolando and the parieto-occipital fissure. The occipital lobe consists of that part of the hemisphere below the parieto-occipital fissure. The temporo-sphenoidal lobe is that part which occupies the middle fosse of the skull, and is bounded before and above by the fissure of Sylvius and joins the occipital behind. The Island of Reil, or central lobe — the fifth primary lobe — lies deep in the fissure of Sylvius, but does not show on the surface. Each of these primary lobes is subdivided, by secondary fissures, of more or less regularity, into secondary lobules called convolutions.

(K1) Bregma.

(K2) Parieto-frontal suture, crossing temporal ridge — the dotted semicircular line.

(K3) Anterior inferior angle of parietal, joining the sphenoid and frontal bones, and where the suture begins.

(M) Point on squamous suture crossed by a perpendicular line from depression in front of the meatus to the bregma.

(L1, L2) Parieto-occipital fissure.

The numbers (1) to (14) and the letters (a), (b), (c), (d), refer to cortical centers, and are the same as in description of following diagram.

(S) Main part of fissure of Sylvius, separating the frontal from the temporo-sphenoidal lobes. It divides into an ascending, or perpendicular, and a horizontal ramus. The latter is bisected at the point (M).

(C) Fissure of Rolando, or central sulcus.

(A) Ascending frontal convolution.

(B) Ascending parietal convolution.

(f 1) First or superior frontal fissure, corresponding to a curved line drawn parallel to the longitudinal fissure beginning at the supraorbital notch.

(f 2) Second or inferior frontal fissure, a little below, but nearly corresponding to the temporal ridge.

(f 3) Pre-central fissure — sometimes called an extension of the ascending ramus of the fissure of Sylvius. It corresponds to the parieto-frontal suture, and is frequently joined at right angles by (f 1) the first, (f 2) second, and (f 3) third frontal convolutions.

(i, p) Inter-parietal suture separating (P 1) superior parietal lobule or convolution from (P 2) inferior parietal lobule or convolution. The upper part of (P 2) is the supra-marginal convolution or gyrus, and the lower and posterior part is the angular convolution or gyrus.

(c, m) End of calloso-marginal fissure.

(P, o) Parieto-occipital fissure — the division between the parietal and occipital lobes — and nearly corresponding to the beginning of the occipito-parietal suture.

(L1, L2) Points on the parieto-occipital suture.

(o) Transverse occipital fissure.

(o 2) Inferior or longitudinal occipital fissure.

(O1, O2, O3) First and third occipital convolutions.

(t 1) First temporo-sphenoidal fissure — nearly parallel with horizontal branch of fissure of Sylvius, and nearly midway between it and

(t2) Second temporo-sphenoidal fissure.

(T1, T2, T3) First, second and third temporo-sphenoidal convolutions.

DIAGRAM OF UPPER SURFACE OF THE BRAIN.

This plate shows three of the primary lobes: the *frontal*, with its four subdivisions—the first, second, third, and ascending frontal convolutions; the *parietal*, with its four subdivisions—the ascending, superior, supra-marginal, and angular convolutions; the *occipital*, with its three convolutions—only the first and second appearing.

The figured and lettered circles are the cortical areas, mapped out on the surface, corresponding to various centers which have been located by the experiments and observations of Farrier and others.

The motor areas in general are in close relation to the fissure of Rolando, especially in the ascending frontal and parietal convolutions.

(1) On superior parietal lobule: centers for advancing opposite leg and foot, as in walking.

(2, 3, 4) Around upper end of fissure of Rolando: centers for complex movements of arms, legs and trunk combined, as in climbing and swimming.

(a, b, c, d) On the ascending parietal convolutions: the centers for fingers and wrist—prehensible.

(5) Posterior end of first frontal convolution: for reaching out the arm and hand.

(6) On the ascending frontal: for flexing and supinating forearm and hand—especially for the biceps.

(7, 8) Middle of same convolution: for elevation and depression of the angle of the mouth.

(9, 10) Broca's convolution—the *aphasiac* region: for movements of lip and tongue.

(11) Between (10) and lower end of the ascending parietal: retraction of angle of mouth—the *platysma*.

(12) Posterior parts of first and second frontal convolutions: for lateral movements of head and eyes, elevation of eyelids and dilatation of pupil.

(13, 13′) Supra-marginal and angular convolutions: centers of vision, with which the occipital lobe is also concerned.

(14) On superior temporo-sphenoidal: for center of hearing.

The center for smell is in the *hippocampal* lobule, not shown on the surface. Near by is the center of taste.

The center for sense of touch is in the hippocampal region and *gyrus fornicatus*.

CRANIO-CEREBRAL TOPOGRAPHY—LANDMARKS AND RULES FOR LOCATING, ON THE SKULL OF THE LIVING SUBJECT, THE POSITION OF THE LOBES, PRINCIPAL BLOOD-VESSELS, FISSURES AND CONVOLUTIONS OF THE BRAIN.

(L) Lower border of orbit.

(E) External angular process.

(T) Beginning of temporal ridge.

(S) Supra-orbital notch.

(G) Glabella — prominence just above root of nose.

(B) Bregma — junction of inter-parietal and fronto-parietal sutures.

(+) Center of parietal protuberance.

(O) Occipital protuberance.

(M) Posterior border of mastoid.

(D) Depression in front of external auditory meatus.

(H L) Horizontal base line from lower border of orbit

through middle of meatus to the occiput. Plain lines indicate position of primary fissures. Dotted lines, the secondary fissures or sulci.

(a, b) Imaginary lines which arbitrarily mark the division between the parieto-occipital and temporo-sphenoidal lobes.

The *longitudinal fissure* corresponds to the curved line (G O), and separates the hemispheres of the cerebrum.

The *transverse fissure* (O D) is represented by a line from the occipital protuberance to the meatus, and corresponds to the superior curved line of the occipital bone, marking the separation of the occipital lobe from the cerebellum by the tentorium.

The *fissure of Sylvius* is indicated by a line starting one and one-fourth inches behind the external angular process of the frontal bone (E), and ending three-fourths of an inch below the center of the parietal protuberance (+). The first three-fourths of an inch is the main fissure, at the end of which it divides into the ascending branch, which extends upward an inch from the horizontal branch just given. The division is beneath the anterior inferior angle of the parietal bone. The motor speech center is just in front of the vertical branch of this fissure.

The *fissure of Rolando.* Draw the lines from (D) to the bregma (B) and from (M) to (F), perpendicular to the base line (H L). (F) can also be located by taking fifty-five and seven-tenths per cent. of the distance from (G) to (O). The fissure is represented by a line from (F) to the intersection of the fissure of Sylvius with the perpendicular line (D B).

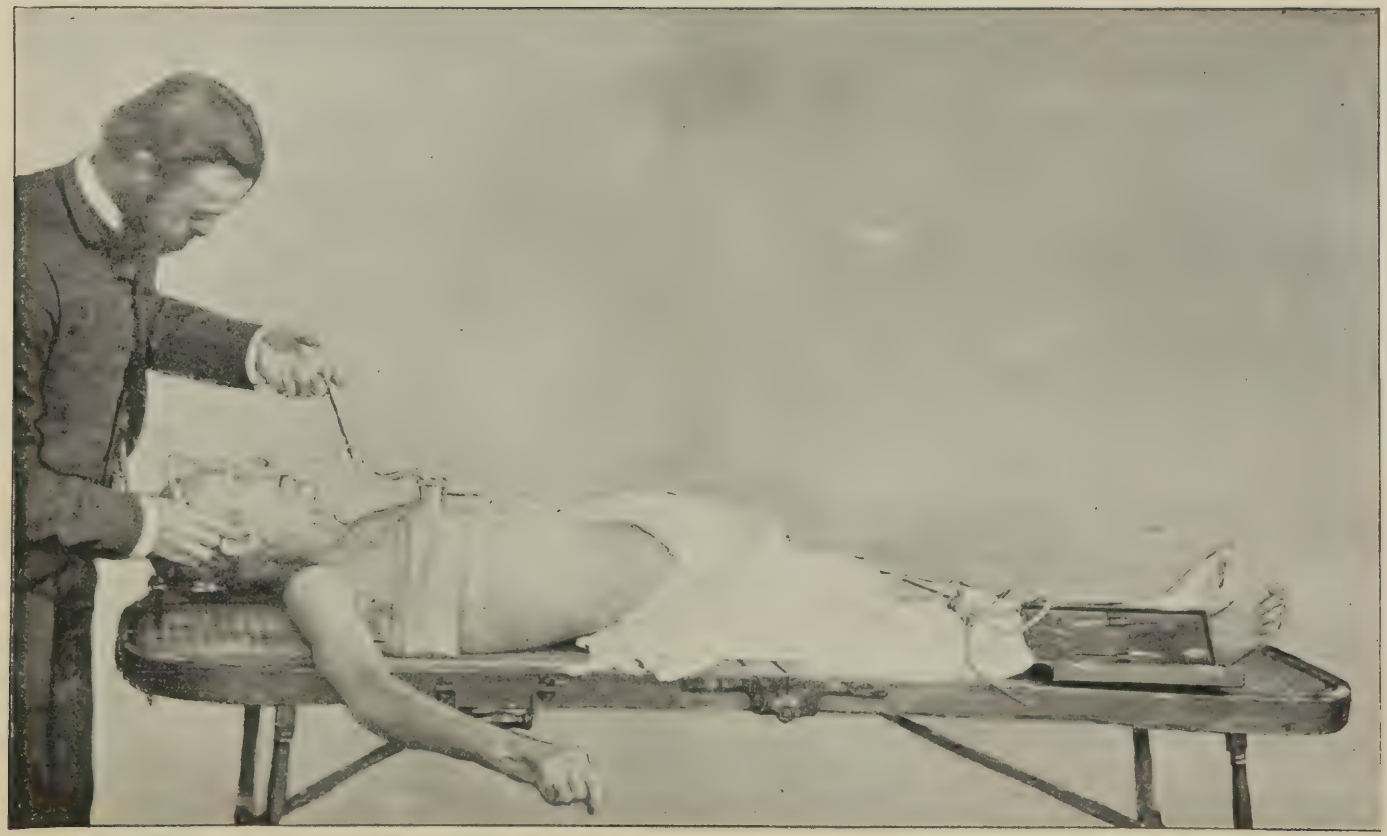
The *parieto-occipital fissure* is an inch long and at right angles to the longitudinal fissure. It is one-fourth of an inch in front of the junction of the lambdoidal and inter-

parietal sutures, and is about twenty-three per cent. of the distance from (O) to (G). Also, if a line corresponding to the horizontal branch of the fissure of Sylvius were extended to the longitudinal fissure, the last inch would represent the parieto-occipital fissure.

These primary fissures divide the outer surface of the hemisphere into its four principal lobes, as follows. The *frontal lobe*, which is limited behind by the fissure of Rolando, and occupies the anterior fossæ of the bones of the skull. It has on its surface three secondary fissures or sulci. The *first frontal fissure* is parallel with the longitudinal fissure, and midway between it and the temporal ridge beginning at the supraorbital notch (S). The *second frontal fissure* is approximately represented by the temporal ridge on the frontal bone. The *precentral fissure* begins just above the upper end of the vertical branch of the fissure of Sylvius, and extends half way to the longitudinal fissure. It lies beneath the fronto-parietal suture, or just behind it. The frontal convolutions are found between these various fissures.

The *parietal lobe* is limited, in part, by the fissure of Rolando in front, and the parieto-occipital fissure behind. Of its four convolutions, the *ascending parietal* lies behind, and parallel with, the fissure of Rolando; the *supramarginal*, around the upper end of the horizontal branch of the fissure of Sylvius; beneath the parietal eminence, and a little below it, the perpendicular line (M F) separates it from the *angular convolution*.

The *inter-parietal fissure* is nearly indicated by a line starting on the fissure of Sylvius three-fourths of an inch behind the fissure of Rolando, running parallel with the longitudinal fissure, passing within one-half inch of the other end of the parieto-occipital fissure.



OPERATOR REMOVING DISCOLORATIONS FROM THE FACE BY HYPERDERMIC INJECTION.

(See page 99.)

The *occipital lobe* is limited above by the parieto-occipital fissure extended as the curved line (a) to the end of the fissure of Sylvius. It is arbitrarily limited in front by the line (C) (b).

The *temporo-sphenoidal lobe* lies in the middle fossæ of the skull, and is bounded above by the fissure of Sylvius, its lower border corresponding to the zygoma, and a line continuing it to the superior curved line of the occipital bone. Its anterior limit is the posterior superior border of the malar bone. It is about one and five-eighths inches wide at the meatus.

The *first temporo-sphenoidal fissure* is parallel with the fissure of Sylvius, and an inch below it.

The *second temporo-sphenoidal fissure* is three-fourths of an inch below, and parallel with, the first.

The posterior limit of the *optic thalamus* corresponds to the perpendicular line (M F).

The anterior limit of the *corpus striatum* is a little in front of a vertical line from the beginning of the fissure of Sylvius.

Of the fifteen cerebral venous sinuses only two are in such relations to the skull as to be of practical importance in trephining for traumatic or pathological conditions.

One is the *longitudinal sinus*, which corresponds to the curved line (G) (O), but it is slightly to the left of the median line, and increases in width from before backward. The other is the *lateral sinus*, which is indicated by the line from (O) to the auditory meatus, and corresponds to the superior curved line of the occipital bone. It marks the inner surface of the tip of the posterior-inferior angle of the parietal bone. Hemorrhage from these sinuses is a serious complication of wounds, either operative or accidental, but, on account of the low blood-pressure in them,

is easily arrested by light pressure or fine cat-gut suture — the latter being difficult to apply in the midst of a free bleeding.

The *middle Meningeal* artery is the chief supply of the skull and dura mater, and is the only artery to be avoided in operations on the skull. The only part of it likely to be wounded is its main branch, which corresponds to the middle of the anterior-inferior angle of the parietal bone, ascending behind but nearly parallel with the fronto-parietal suture. The next large branch is horizontal, and corresponds nearly with the second temporo-sphenoidal fissure (which see). Hemorrhage from these branches is annoying, but usually not serious, as it can generally be arrested by the usual means — forci-pressure is often the best means. Still, they are to be avoided in operations, when possible.

THE EYE.

The organ of vision consists of the Globe and its protective organs, as the Eyelids and the Lachrymal Apparatus.

The eyelids are two elliptical structures consisting of strata of different tissues. The strata are :

I. The *skin.*

II. The *orbicularis muscle* (4), which closes the lids, is of thin, pale fibers, and supplied by the facial nerve as one of the muscles of expression. A thicker part of this muscle surrounds the borders of the orbit.

III. The *tarsal cartilage*, which is a rigid plate of connective tissue held in place by the tarsal ligaments, which extend from their outer border to the periosteum of the

orbit, and which prevent pus, in suppuration of the lid, from passing back into the orbit.

IV. The expanded tendon of the *levator palpebræ* (upper lid only).

V. *Meibomian* (*sebaceous*) *glands*, (2) whose ducts open on the free margins of the lid, (3) the fatty secretion of which prevents the overflow of tears.

VI. *Mucous membrane* (*conjunctiva*), which secretes some mucus, and forms the posterior layer of the eyelid.

The eyelids contain no fat, but the different strata are held together by delicate areolar tissue. The upper lid is the larger and more movable. The interval between the two lids is the *palpebral fissure*. The junction of the lids, at the ends of the fissure, makes the *inner canthus* and the *outer canthus*. Near the inner canthus each lid has a papilla, in which is a small opening to receive tears, the *punctum lachrymale* (5).

The tear apparatus consists of the *lachrymal gland* (1), situated below the external angular process of the frontal bone, and whose excretory ducts (eight to ten) perforate the conjunctiva on the under surface of the upper lid; the *puncta* (5), which are the outer openings of the *canaliculi* (6) (upper and lower), which join to form the *lachrymal sac*, from which passes downward (7) the *nasal duct*, opening into the *inferior meatus* of the nose, toward the front. The upper canaliculus first ascends vertically, dilates into a small pouch, and then runs, a quarter of an inch, transversely. The lower descends vertically at first, and is shorter and thicker. The nasal duct is three-fourths of an inch in length, and is directed downward, backward and slightly outward.

The globe is held in its place in the orbit chiefly by the four *recti* muscles (8), which, with the two *oblique*,

move it on its posterior cushion of fat, as a ball and socket joint.

(9) Junction of *cornea* with (10) *sclerotic*, which posteriorly is continuous with the fibrous covering of the optic nerve derived from the dura mater.

(11) *Iris*, which contains two muscles — the circular (*sphincter*), which surrounds the pupil, lying near the posterior surface, and is supplied by the third nerve; and the radiating muscle (*dilator*), which is chiefly supplied by the sympathetic. The iris is suspended in the fluid (*aqueous humor*) which fills the space between the cornea and the *lens*. The space in front, the anterior chamber, connects through the pupil with the posterior chamber.

(12) *Ciliary processes*, radiating folds of the *choroid* (13), sixty or seventy in number. The *ciliary muscle* (muscle of accommodation) is a ring of unstriped fibers placed at junction of iris and choroid between the ciliary processes and the sclerotic.

(14) The *retina*, the expansion of (15) the *optic nerve*.

THE EAR.

The organ of hearing consists of the outer cartilaginous part, the Pinna; the External Auditory Meatus; the Tympanum or Middle Ear; and the Labyrinth or Internal Ear, comprising the Vestibule, Cochlea, and Semicircular Canals. The *pinna* is composed of yellow fibro-cartilage, and has a tubular prolongation inward to form a part of the meatus.

(1) A sectional view of the bony part of the external auditory meatus. The whole canal is one inch and a quarter in length, the cartilaginous portion forming a little

less than one-third. The narrowest part of the canal is about its middle. Hence the difficulty of extracting foreign bodies which get beyond this constriction. The direction of the canal is, at first, inward, forward, and upward; then it curves slightly downward. The floor is a little longer than the roof, owing to the tympanic membrane being placed obliquely.

(2) The *membrana tympani*, a thin, semi-transparent, membranous disc, slightly oval in shape, forming a complete partition between the external auditory canal and the middle ear. It has a thin layer of true skin on its outer surface. Its inner surface is lined with the mucous membrane of the tympanum. It is supplied with sensation, in connection with the auditory canal, by a branch from the auriculo-temporal of the third division of the trifacial.

(3) Inner surface of membrana tympani, against the upper half of which lies, vertically, the handle of the *malleus* (4).

(5) The *incus* or anvil bone.

(6) The *stapes*, or stirrup bone, the base of which is attached to the membrane of the *fenestra ovalis* on the inner wall of the cavity of the tympanum. From the anterior wall of this cavity the *Eustachian tube* leads downward, forward and inward to the pharynx. On the posterior wall are three or four openings which convey air to the mastoid cells.

The internal ear consists of (7) the three semicircular canals behind; in front, (8) the cochlea; and the vestibule, a small cavity placed between (7) and (8).

(9) Termination of the auditory nerve in the cochlea.

The cochlea is in the form of a snail shell. Its base, one-fourth of an inch in diameter, corresponds to the bot-

tom of the internal auditory meatus — the apex being directed outward and forward.

The auditory nerve, the portio mollis of the seventh pair, after passing down through the internal auditory meatus, divides into two sets of branches, the anterior being distributed in the cochlea, the posterior in the vestibule.

PART THIRD

THE MALE AND FEMALE GENERATIVE ORGANS —THE FŒTAL CIRCULATION.

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THE MALE GENERATIVE ORGANS.

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(1) Peritoneum.
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(3) Symphysis Pubis.
(4) Prostate Gland, (4′) Section of.
(5) Vesiculæ Seminales and Vas Deferens.
(6) Rectum, External Coat.
(7) Glans Penis.
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(9) Corpus Cavernosum.
(10) Corpus Cavernosum, Section of.
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(12) Bulb of Urethra.
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(14) Spermatic Vein.
(15) Spermatic Artery.
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MALE GENERATIVE ORGANS.

These consist of *penis* and *testes* and their appendages. The *penis* (8) is the organ of copulation. It consists of a *body* (8) and *glans* (7).

The *body* at its base is firmly connected to the rami pubis by fibrous crura, and to the symphysis pubis (3) by a suspensory ligament.

The *glans penis* (7) is cone-shaped. A vertical fissure, at its summit, is the orifice of the *urethra*, called *meatus urinarius*. The base of the glans is a rounded ridge (*corona glandis*) and behind this ridge a deep depression (*cervix*). Buried in this depression are numerous sebaceous glands, secreting an odorous matter. Want of cleanliness causes an accumulation of this secretion, with irritation. The mucous membrane covering the glans penis contains no sebaceous glands, but has on its surface a number of sensitive papillæ.

The body of the penis, when flaccid, is cylindrical; when

erected, triangular. It is composed of a mass of erectile tissue (26) inclosed in three cylindrical fibrous compartments. Two of these, the *corpora cavernosa* (9), lying side by side, form the upper part of the penis. The third, the *corpus spongiosum* (36), incloses the urethra, and forms the under portion of the penis.

The corpora cavernosa consist of a very firm, highly elastic fibrous envelope, which contains meshes of fibrous and erectile tissue (10). The union of the corpora forms a groove above, in which run the dorsal vessels (28) of the penis, and a deeper groove below, in which lies the corpus spongiosum, inclosing the urethra. The arteries of the corpora cavernosa (27) are derived from the *pudic*. They terminate in curling, dilated extremities (*helicine*), which allow them to accommodate themselves to the erection of the organ without stretching.

The corpus spongiosum receives its arterial supply from the *internal pudic*. The upper portion of the penis can thus be erected without the lower.

The penis is supplied with lymphatics. Its nerves are derived from the *internal pudic* and *hypogastric plexus*.

The cutaneous covering of the penis is extremely elastic, like that of the scrotum. It is finer and of darker color than that of the surrounding parts. It is attached loosely to the penis by a connective tissue which contains no fat, and therefore allows of great motion.

It is possible, in performing circumcision, to draw the foreskin so far forward as to cut off the whole skin covering the penis. It is therefore necessary to mark the line of incision before drawing forward the foreskin.

The *urethra* (36, 38, 39) is the canal for the discharge of the urine and the semen. It is eight or nine inches

long, and extends from the bladder (2) to the fissure of the glans penis (7). From the latter its direction is practically straight until it reaches the membranous portion (38), when it begins to curve upward and forward to enter the bladder. Inflexible catheters and sounds are made to imitate and accommodate this curve.

Anatomically, the canal of the urethra is divided into three portions, the *spongy* (36 the *membranous* (38), and the *prostatic* (39).

Gonorrheal inflammation, at times, invades the glandular structures of the prostate, establishing a most intractable disease.

The *testicle* (20) is the organ of seminal secretion. It lies in a special cavity called the scrotum, suspended by a collection of structures called the spermatic cord (18).

The *scrotum* consists of three layers, namely, the *skin*, the *tunica fibrosa*, and the *tunica vaginalis*. The scrotum contains two cavities — a right and a left — each containing a testicle, and each communicating with the abdominal cavity through the *inguinal canal* (18). The nerves and blood-vessels of the testicle pass through this canal and constitute the spermatic cord. The cavity of the scrotum, which is a serous cavity, may be filled and distended with fluid, as the result of inflammation, causing *hydrocele*. Through the inguinal canal also a loop of intestine may descend, producing *inguinal hernia*.

The *testicles* (20) are two in number, a right and left. The left hangs lower than the right to prevent injury when the thighs are brought together. During fœtal life the testicles lie just below the kidneys, and gradually descend to the inguinal canal as pregnancy advances to term. At birth, the testicles should be found in the scrotum. At times, one, and more rarely both, remain in the abdominal

cavity. Where both are retained, sterility generally exists. Absence of the testicles (*anorchus*) occurs rarely, and produces impotence. The testicles often become diseased, requiring removal. This operation is called *castration*, and when performed on both sides unsexes the patient and causes impotence. The testicle is covered with a fibrous capsule (20) (*tunica albuginea*), and contains a glandular secreting substance (34) and vessels (25) and nerves.

The fibrous capsule of the testicle is covered by the *tunica vaginalis*, which is adherent to it, and also invests and binds to the testicle the *epididymis*. Beneath the tunica albuginea is a fine network of blood-vessels (*tunica vasculoso*), which supplies the secreting substance.

Prolongations inward of the tunica albuginea, called *septa*, divide the substance of the testes into lobules. These lobules, 200 or 300 in number, consist of two or three convoluted seminal tubes of a diameter of 1-200 of an inch. Each lobule is inclosed in a delicate plexus of blood-vessels. At the apices of the lobules the seminal tubes become straight, and pass upward, freely anastomosing, finally terminating in 15 or 20 ducts (32). These ducts perforate the tunica albuginea, carrying seminal fluid from the testes to the epididymis (33). Here they enlarge and become very much convoluted (33). They then descend downward (31) to the base of the testicle, where, by union, they become one tube, the *vas deferens* (30).

Inflammation of the epididymis leads to temporary or permanent obliteration of the vas deferens, causing temporary or permanent sterility. The vas deferens is thus the final outlet of the secretion of the testes. Commencing at the lower part of the epididymis, it ascends along

its posterior side (30) and along the back part of the spermatic cord, until it reaches the inguinal canal (16). Entering the pelvic cavity, it descends along the side of the bladder (2), passing downward and backward toward its base. At the base of the bladder, it lies between that organ and the rectum. (6). In this position it becomes enlarged and sacculated (5) until it reaches the base of the *prostate* (4), where it narrows and unites with the *vesicula seminalis* (5) to form the ejaculatory duct. These ducts run forward through the prostate to discharge the semen into the urethra (38).

The *seminal vesicles* (5) are two sacculated pouches lying on each side of the base of the bladder, just outside of the vasa deferentia. They act as seminal reservoirs. They may be felt by examination through the rectum.

The blood-vessels of the spermatic cord are the *spermatic* (22), *deferential* and *cremasteric arteries*, and the *spermatic veins* (23). The spermatic veins form a plexus of vessels, and make the chief mass of the cord. They often become varicosed, forming what is called *varicocele*.

The *semen* is a complex fluid, consisting of secretions from the testes, prostate, seminal vesicles and Cowper's gland. Examined under the microscope, it is found to contain numerous filaments possessing rapid undulatory movements. These are called *spermatozoa*. They are the impregnating agents of the semen. Absence of them in the seminal fluid indicates sterility.

Acids arrest the movements of the spermatozoa. Alkaline solutions stimulate their motion. Acrid vaginal discharges may thus be a cause of barrenness. Menstrual blood and alkaline mucus discharges from the womb prolong their vitality. For this reason they have been found in motion a week after coitus.

THE FEMALE GENERATIVE ORGANS.

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FEMALE GENERATIVE ORGANS.

The female generative organs are divided into two groups: the *external* and the *internal.*

The external generative organs are called the *pudenda* (pudere — to be ashamed), and comprise: the *mons veneris*, *labia majora*, *labia minora* (B), *clitoris* (G), and *hymen* (M). These form the *vulva*, or orifice of the vagina.

The internal organs comprise: the *vagina* (C), *uterus* (U), *Fallopian tubes* (F T) and *ovaries* (O).

EXTERNAL GENITAL ORGANS.

The *mons veneris* is a fatty cushion covered with hair after puberty, containing sebaceous glands, resting upon the symphysis pubis. It is the base of the external abdomen and the upper and anterior junction of the labia majora.

The *labia majora* (N) are two longitudinal tegumentary folds, rounded and slightly curved. They bound the orifice of the vagina on each side, and act as a sort of valve closing it — whence the term vulva. Their superficial surface is true skin sparsely covered with hair. Their

inner surface is mucous membrane, but contains sebaceous instead of mucous glands.

The shape and size of the labia majora vary with age. In the young virgin they are rounded and firm, completely closing the vaginal orifice. In married women who have borne children, they are less rounded and gape apart. In old age they are shrunken and wasted.

The *labia minora* (B) are two membranous folds of a shell pink color, situated between the labia majora. Their outer surface is continuous with the labia majora, and their inner surface with the mucous membrane of the vagina (C). They are also called *nymphæ* (goddesses of the fountain), because they were supposed to direct the stream of urine.

Superiorly, each labium splits into two folds, one of which passes over, the other under, the *clitoris* (G) to unite with the corresponding folds of the opposite side. Thus are formed the *præpuce* and *frenulum* of the clitoris. Below, the labia minora pass around the orifice of the vagina, and unite to form the *frenulum vulvæ*, or *fourchette*.

The *clitoris* (G) is a small, elongated, spongy body, lying below the upper junction of the labia majora (N). It is hung from the *symphysis pubis* (24) by a suspensory ligament, and protrudes from the folds of the labia minora (B). It resembles the penis in possessing crura, corpus and glans, lacking, however, corpus spongiosum and urethra.

The crura (17) are long, slender processes, of spindle shape, attached to the rami of the pubes (24), uniting to form the corpus or body. The extremity of the body is the glans (G), of a pale red color, and covered with papillæ. These contain nerve endings of extreme sensitiveness.

In a state of erection, the clitoris measures less than an inch in length. This erection of the clitoris occurs from emotional or mechanical excitement, and is due to the filling of its spongy body with blood from its appropriate vessels (1), (12), (13).

The *meatus urethræ* (A) is situated about three-quarters of an inch vertically below the clitoris (G). It is the lower boundary of the *vestibulum*, which is a space bounded by the clitoris (G) above, the labia minora (B) at the sides, and the vaginal orifice below(C). The meatus is surrounded by a sphincter muscle, which puckers the mucous membrane, and serves as a guide for the introduction of a catheter. The urethra is larger and shorter in women than in men, and can easily be dilated for the introduction of the finger into the bladder.

The *Hymen* (M). — In virgins the anterior extremity of the vagina is closed by a double fold of mucous membrane called the hymen. The inner surface is a continuation of the mucous lining of the vagina (C); the outer, that of the labia minora (B); between these layers of mucous membrane are some connective tissue, muscular fibers and blood-vessels. The hymen is usually crescentic in shape, its concave border looking upward. There are, however, other forms, viz.:

1. Hymen cribriformis, with a number of small openings.

2. Hymen annularis, where it is like a ring, with the opening in the center.

3. Hymen imperforatus, when there is no opening at all, and menstrual blood is retained after puberty, requiring surgical interference.

4. Hymen fimbriatus, where it looks as if the virgin had been deflowered, and the hymen torn. At times there

is no hymen at all; and, again, the hymen may be so distensible that coitus can take place, and it be not ruptured. Absence of hymen is therefore no positive sign of coitus, and its presence no sure proof of chastity; while the hymen fimbriatus resembles, but is no proof of, laceration from intercourse.

INTERNAL ORGANS OF GENERATION.

The *vagina* (C) is the canal which connects the uterus with the external genital organs. Its walls are composed of mucous membrane, connective, elastic and muscular tissue, and in its upper portion, posteriorly, peritoneum. Unless artificially distended, its anterior and posterior walls lie in contact. The anterior wall is nearly an inch shorter than the posterior one, whose length is about three and a half inches. The vagina lies between the bladder (Bl) and the rectum (R), and is closely united to them, forming the *recto-vaginal* and *vesico-vaginal septa*. The upper fifth of the posterior wall is separated from the rectum by a fold of peritoneum, called Douglas' cul-de-sac. This is the only point where the abdominal cavity can be entered from the vagina. This is often taken advantage of to drain the abdominal cavity after laparotomies. The upper part of the vagina encircling the cervix uteri, and attached to it, is called the *fornix*.

The mucous lining of the fornix is comparatively smooth. As the canal, however, is descended, the walls thicken, particularly on the anterior and posterior aspects, throwing the mucous membrane into folds, and forming the anterior and posterior vaginal columns. The mucous membrane of the vagina is also covered with vascular papillæ, and contains scattered mucous follicles, which keep its surface constantly moist with an acid mucus.

The vagina receives its blood supply from the *hypogastric*, the *vesical*, the *uterine*, and the *pudendal* arteries, and returns the blood through the corresponding veins, which form a close plexus around it. As these veins have no valves, and anastomose freely with the veins of other pelvic organs, it can readily be seen that any disturbance of return circulation will impart a purplish color to the vagina, and it will be congested by the congestion of any other pelvic organ. Thus, when pregnancy causes descent of the womb, and disturbance of its return circulation, the vagina also becomes congested, and its purplish color becomes one of the signs of pregnancy. In the same way congestion of the rectum, causing piles, will also congest the vagina, and cause excessive mucous secretion, termed *leucorrhœa*, or whites.

The *uterus* (U) is the organ that contains, nourishes, and finally expels the fœtus. In the virgin it resembles an inverted wide-necked flask. It is about two and one-half inches in length, and is divided by a well marked contraction into two nearly equal parts. The upper half is called the *body*, the lower the *cervix*. The body is egg-shaped, but flattened in front. The cervix is cylindrical, with a rounded lower extremity. This is surrounded by, and protrudes into, the vagina. It possesses an oval aperture, leading to the cavity of the womb. This opening is called the external os, or *os tincæ*, from its supposed resemblance to the mouth of the Tench.

Maternity changes permanently the uterus. The body becomes rounder and larger, proportionately, than the cervix. The cervix becomes broader and less firm at its apex, and the external os, on account of laceration of its border during labor, becomes a ragged slit.

On making a lateral section of the uterus, its cavity (U')

is opened. This is found to be triangular in shape, with convex sides.

The base of the triangle is the *fundus.*

At the two angles of the base are found the fine openings (the size of a bristle) leading into the Fallopian tubes (F T′). The apex of the triangle is the *internal os*, a round orifice sufficiently large to admit a uterine sound.

The canal of the cervix (Z), which lies between the internal and external os, is spindle shaped. Its inner surface, like the vagina, possesses an anterior and posterior ridge, called *arbor vitæ* (Z), from its resemblance to the leaves of that tree.

The position of the uterus in the pelvis, and its attachments, allow it great freedom of motion.

Its lower extremity projects into the vagina, its anterior surface is attached to the bladder (Bl). The fundus is covered by the peritoneum (P), which descends over the body of the uterus front and rear. These folds of peritoneum meet at the sides, covering the Fallopian tubes (F T), ovaries (O), blood-vessels and nerves, and are called the broad ligaments. They divide the cavity of the pelvis into two nearly equal halves. In operations for the removal of the uterus, these ligaments must be carefully ligated before section.

Two other folds of peritoneum, carrying with them muscular fibers from the uterus, pass backward on each side of the rectum to the sacrum, and form the *sacro-uterine* ligaments. Two more peritoneal folds, also carrying muscular uterine fibers, pass forward on each side of the bladder to the inguinal canals, and are called the round ligaments of the uterus. Cutting down on the inguinal canal, and drawing out and shortening these round liga-

ments, is called Alexander's operation. This operation corrects retroversion of the uterus.

The six ligaments thus holding the uterus in position allow of much extension; so that for surgical procedures the cervix can be drawn almost to the mouth of the vagina.

Relaxation of these ligaments causes the various displacements of the womb.

The muscular tissue of the womb, which consists of three layers, is of the unstriped variety, and, therefore, involuntary in its action.

The mucous membrane of the body of the uterus is soft and smooth. It is filled with glands which secrete an alkaline mucus. Between these glands is an abundant capillary network of blood-vessels, which is the source of the menstrual hemorrhage

The mucous lining of the cervix is yellowish-red in color, firm and ridged, and can readily be distinguished from the smooth red lining of the body. Its glands secrete an abundant glairy white mucus—like the white of an egg. This mucus, in chronic catarrhal inflammation of the membrane, often causes sterility by closing the cervical canal to the spermatozoa.

The *Fallopian tubes* (F T) are practically continuations of the uterus. Their cavity (F T′) communicates directly with the uterine cavity, and their mucous lining and muscular tissue proceed from the latter organ. These tubes are from three to four inches long. As they proceed from the uterus, their canal is straight and narrow, but it soon becomes sinuous and enlarged, and terminates in a fringed (fimbriated) extremity (L). One fimbria, longer than the others, is attached to the outer border of the ovary (K). During ovulation the fimbriæ apply them-

selves to the ovary, and establish a continuous canal to the uterus for the conveyance of the spermatozoa and the passage of the ovum.

The muscular walls of the tubes are of involuntary fiber, and have a peristaltic movement.

The *ovaries* (O), two in number, are the analogues of the testes of the male. They lie in the broad ligaments, directly below the Fallopian tubes (F T). They are ovoid in shape, about one inch long, three-fourths of an inch wide, and a half inch thick. Each ovary is attached to the uterus by a ligament (N) about an inch long, and at its opposite extremity to one of the fimbriæ of the Fallopian tube (K). On section, the ovary (O′) is found to contain within its tunic a central red medullary substance, and a surrounding gray cortical substance. The granular appearance of this cortical substance is due to a vast number of vesicles called Graafian, after their discoverer. Each vesicle contains an ovum which is susceptible, on maturity, of impregnation and of subsequent development, in the uterus into a fœtus

BLOOD-VESSELS OF UTERUS AND ITS APPENDAGES.

Arteries: 1. *Arteria uterina hypogastrica.* — This arises from the hypogastric. It descends downward to reach the vagina, then bends upward between the folds of the broad ligament, and pursues a tortuous course along the sides of the uterus.

2. *Arteria uterina aortica.* — This artery springs from the aorta about two and a half inches above its bifurcation. It descends to the pelvis with many a spiral curve, and then ascends between the folds of the broad ligament to supply the fundus of the uterus, Fallopian tubes and ovaries.

These two arteries communicate freely.

The circumflex branch, uniting the arteries of each side, and placed around the location of the internal os, is of surgical interest, as it may be wounded in lacerations of the cervix, or in operations therefor. The blood flows from two plexuses of veins, viz.:

1. *Plexus uterinus* (W).
2. *Plexus pampiniformis* (V).

These form a close network of veins about the uterus, Fallopian tubes and ovaries. The first empties into the hypogastric, and the second the spermatic vein.

The uterus also contains an abundant supply of lymphatics and of nerves of sympathetic origin

DEVELOPMENT OF THE OVUM.

The fecundation of the ovum takes place at the surface of the ovary (O), or in the Fallopian tube (F T). It consumes a week in reaching the cavity of the womb (U'). During this time the uterine mucous membrane has become congested and thrown into folds (a), within one of which the impregnated ovum is soon entangled and attached. As soon as the ovum has thus secured a lodgment, the uterine mucous membrane begins to inclose it, forming a complete envelope about it, called *decidua reflexa* (b). The ovum enters the uterine cavity inclosed in its *vitelline membrane*, and the *blastodermic membrane*, resulting from fecundation; subsequently the *allantois* spreads itself over the whole interior of the globe of the ovum, carrying with it the blood-vessels of the growing fœtus. At this stage of development, the embryo (e) is inclosed in the *decidua* (b), derived from the mucous lining of the womb, and the *chorion* (c), (made up of the vitelline membrane, the blastodermic membrane and the

allantois). Simultaneously a third membrane is developed called the *amnion* (d), which directly envelops the embryo, floating in a fluid called amniotic.

As was said before, the allantois (part of the chorion) carries with it the blood-vessels of the embryo. These penetrate the chorion and enter the decidua, coming in contact with, but not mingling with, the maternal blood. This development of blood-vessels on the surface of the chorion makes it *shaggy* (c) in appearance. As the development of the embryo progresses, these blood-vessels disappear from the chorion, except at the point where the decidua lies upon the uterine tissue (c). This becomes the site for the future development of the placenta (g).

The *placenta* (g) is the organ of respiration, nutrition and excretion of the fœtus. After the allantois has spread over the entire inner surface of the ovum, it extends its villi into the decidua, so that nutrition is absorbed by the embryo from the whole surface of the chorion. With the enlargement, however, of the ovum, the decidua reflexa becomes thinned, with an obliteration of its vessels and a corresponding disappearance of the villi of the chorion. Thus the whole process of exchange between mother and fœtus becomes concentrated in the *decidua serotina* (h). This is the site and origin of the *placenta*. The villi of the chorion here wonderfully multiply and branch out, each villosity being followed and surrounded by a corresponding development of maternal vessels. The placenta (g) may then be defined as a mass of connective and vascular tissues representing the site of contact of the maternal and fœtal circulations.

The pedicle of the allantois becomes the *umbilical cord* (f). It consists of two arteries (16) and one vein

(18), embedded in a gelatinous substance and inclosed in the amnion.

During the ninth month of gestation, the tissue connecting the placenta with the uterine wall undergoes fatty degeneration, so that, at term, it is easily separated.

On separation, the uterine muscular tissue is laid bare and its blood-vessels torn.